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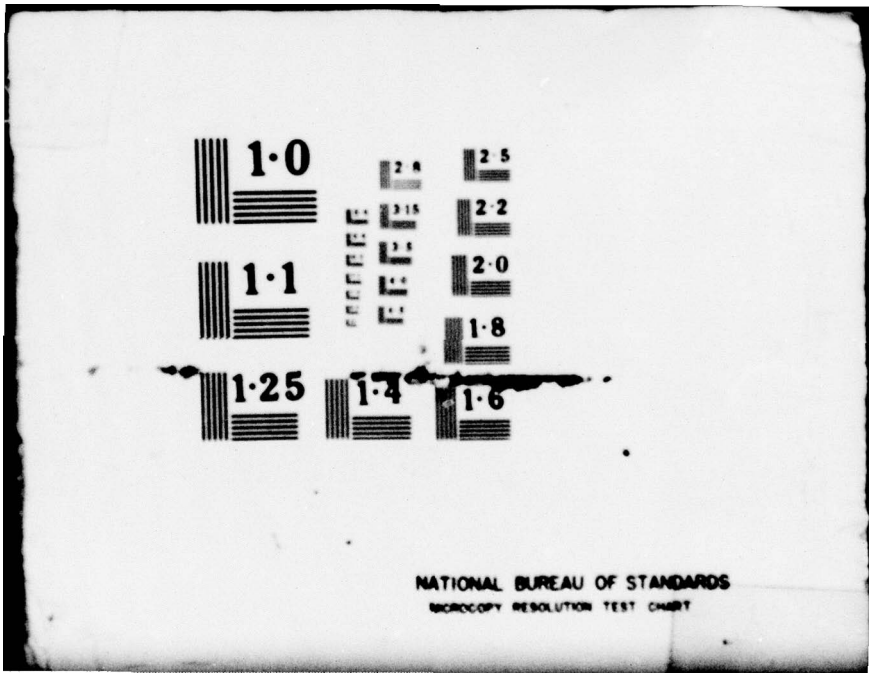
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Technical Document 266

MODELS AND MOCKUPS AS DESIGN AIDS

NJ Buchaca

1 July 1979

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NAVAL OCEAN SYSTEMS CENTER
SAN DIEGO, CALIFORNIA 92152

NAVAL OCEAN SYSTEMS CENTER, SAN DIEGO, CA 92152

AN ACTIVITY OF THE NAVAL MATERIAL COMMAND

SL GUILLE, CAPT, USN
Commander

HL BLOOD
Technical Director

ADMINISTRATIVE INFORMATION

The purpose of this Technical Document is to acquaint NOSC personnel and sponsors with some of the uses and applications of models and mockups as design tools for man-machine systems. With a knowledge of the usefulness of these design aids, project managers and designers may wish to consider using models and mockups in their programs and projects to design, develop and assess systems and equipment.

All of the models and mockups presented in this Technical Document were constructed in the Design Aid Facility of the Naval Ocean Systems Center (NOSC), Man-Systems Interaction Division, Code 823. Analysis and design efforts utilizing these aids were performed in most instances by the Command and Control Analysis and Design Branch, Code 8234.

Further information relative to the use of models and mockups can be obtained by contacting this branch as NOSC (714)225-7372 or AUTOVON 933-7372.

Released by

J. Silva, Head
Command Support Division

Under authority of

J. H. Maynard, Head
Command Control Electronic Warfare
Systems and Technology Department

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This report describes the application of models and mockups as design aids in initially determining or improving control panel layouts and equipment/compartment arrangements to facilitate interactions between personnel and personnel and equipment during system operations and maintenance. The report describes how these models and mockups (M&M) have been used, types of M&M and their applications in various phases of the design development cycle, and

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20. ABSTRACT (Continued)

finally, a description of the use of M&M for man-machine design and design improvements.

Three appendices are included in the report and contain:

1. An M&M Characteristics Checklist to aid in the preparation of M&M specifications
2. Examples of M&M Specifications
3. Descriptions of NOSC M&M Applications.

CONTENTS

INTRODUCTION

Models and mockups (M&M) are primarily representations or simulations of the physical characteristics of equipment components and systems. They may also simulate functional properties. Models as referred to herein are reduced-scale representations, while mockups will denote full-scale objects.

M&M have been used for a variety of purposes in the commercial, industrial and military sectors. The initial impetus for developing an in-house M&M construction and utilization capability was the experience gained in support of the Submarine Communication Program Office in man-machine interaction studies relative to the design of an integrated radio room for the 640 Class submarine. The benefits realized on this project through the use of M&M resulted in their further application on other communications system projects such as TACAMO, TRIDENT and the SSN-688 attack submarine. As these programs progressed, increased uses for M&M became apparent: to develop installation sequences of equipment and operational and maintenance procedures, training aids, familiarization and design review vehicles; to use as visual aids during presentations of various concepts and ideas concerning system and equipment designs; and to identify problem areas in existing systems. A recent application of M&M has been in the study, design and improvement of equipment, work stations and room layouts of the National Military Command and Control Center (NMCC), the Alternate National Military Command Center (ANMCC), as well as the EC-135 and E4A Airborne Command posts. These and other applications and uses are presented in this Technical Document, as well as descriptions of various types of M&M applicable to various phases of the system design and development cycle. A checklist which may be used

by the sponsor and designer to determine M&M specification data for the modelmaker is also provided in Appendix A. Experience in the use of M&M has shown that the cost of these designs is significantly outweighed by benefits realized through their use such as reduced system and equipment design changes and retrofits, drawing changes, timely identification of problems, and inefficiencies associated with operating and maintaining equipment systems, to name just a few examples. Appendix C, Model and Mockup Applications, describes other benefits which have been realized through the use of M&M.

USE OF MODELS AND MOCKUPS

Models and mockups are effective tools for the design or the improvement of man-machine systems and equipment to ensure effective system/equipment operability and maintainability. Representations of an equipment system and its components may include control and display panels, subassemblies, racks and consoles, furniture, and any other items such as ducting and cabling contained in a room or compartment as well as the room itself.

A major use of M&M is to assist designers in determining the most effective equipment arrangements and configurations of equipment controls and displays for man-machine operation/maintenance. Further, M&M are used as analysis and study vehicles to determine the sequence of operations and activities to be performed by equipment operators and maintenance personnel. Analysis of the interactions between personnel and equipment and other personnel in terms of physical, visual, and audio linkages are made using the M&M to determine an optimum design.

M&M can also be used to evaluate competing contractor room layout proposals, document studies and recommendations by means of photographs and videotapes, and to prepare work-station construction specifications. They

have been used during design reviews and for presentations to sponsors, as well as for orientation, training, and marketing purposes.

Some other uses and benefits are:

- Studying flow of personnel and information
- Identifying additional equipment and support requirements
- Optimizing procedures and sequences of activities
- Determining accessibility requirements for ease of maintenance
- Evaluating habitability characteristics
- Guiding assembly of an actual system
- Determining cable and duct routings
- Identifying interface requirements
- Training of operator personnel
- Providing a documentation vehicle
- Providing a configuration management and control tool
- Identifying problems prior to hardware acquisition

Specific project applications of M&M at NOSC are presented in Appendix C.

TYPES OF MODELS AND MOCKUPS

Models and mockups are classified in terms of scale, dimensionality and degree of simulation and detail. M&M may represent two-dimensional or three-dimensional characteristics of the objects being simulated and may be full- or reduced-scale. Another type of mockup is the functional mockup where operating characteristics of an item or equipment are simulated, such as working mechanisms or changeable display formats. The particular phase of the development cycle and intended use of the mockups dictates the type of M&M to be constructed. Table 1 lists various types of mockups, and some of their characteristics and uses.

Table 1. Types and uses of models and mockups.

Type of Model/Mockup	Scale	Uses/Characteristics
Two-Dimensional Model	Reduced	Preliminary room layout and equipment location studies for initial design or design improvement. Presentations, design reviews, documentation. Simple and inexpensive. Lightweight and portable.
Three-Dimensional Model	Reduced	Room layout and equipment location studies where simultaneous consideration of spatial (height, width, depth) interrelationships is required. Provides more realistic visualization of system as compared to two-dimensional models; also greater visual impact. Portable and relatively lightweight. Developing installation sequences.
Two-Dimensional Mockup	Full	Initially determine or improve existing layouts and display on equipment panels for ease of operation/maintenance. Provides more realistic two-dimensional representation by being full-scale. Reveals potential visibility and reach problems of operators. Design review and documentation vehicle.
Three-Dimensional Mockup	Full	Provides more realistic room arrangement, equipment location and control/display layout study vehicle. Provides most realistic visualization of above. Permits accurate and optimum cable and duct routing and equipment accessibility determinations. Preparation of specifications for actual items.
Functional Mockup	Full	Display format development and evaluation. Operator training aid.

MODELS AND MOCKUPS IN THE SYSTEM DESIGN AND DEVELOPMENT CYCLE

NOSC project development requires a logical flow of events in order to result in a high quality end product. The number of events will vary according to the requirements and findings of the project. These events occur within specified phases according to DoD and Navy requirements and are identified as Research, Exploratory Development, Advanced Development, Engineering Development, Operational System Development, and finally, once the system goes into production and deployment, Management and Support. M&M are extremely useful during each of these phases as study and design aids, for documenting and presenting design concepts and final design of equipment configurations, control display layouts, and room arrangements.

These M&M will undergo several stages of refinement as the design and development cycle advances and often will result in final sophisticated model or mockup reflecting the final configuration in every detail, thus providing the basis for detailed specifications.

Table 2 indicates possible applications of M&M during each phase of the system design and development cycle.

MAN-MACHINE ANALYSES WITH M&M

As indicated previously, the primary uses of M&M are as tools in initially designing a system, or improving an existing system design, so as to optimize the man/machine interactions associated with operating and maintaining the system.

The design or design improvement process consists of a number of interrelated efforts, i.e., familiarization with the system and its requirements, identification and collection of data and information, analysis of the data, development of system and equipment design specifications, and finally, man-machine interaction tests and evaluations.

Table 2. Model and mockup applications of the system design and development cycle.

Design/Development Phase	Model and Mockup Application
Exploratory Development [Funding Category (FC) 6.2]	To develop and portray concepts of equipment configurations and room layouts to the DCAS-I and other interested persons. To document the above with photographs of the models/mockups. To identify potential problem areas and additional study requirements.
Advanced Development (FC 6.3)	To aid in the preliminary design of equipment operating and maintenance panels. To aid in the identification of design requirements for ease of maintenance of equipment, e.g., accessibility features in terms of assembly, subassembly and component locations and arrangements, access covers, mounting hardware, test point locations, etc. To define and amplify on studies conducted during Exploratory Development. To develop preliminary specifications for equipment operability and maintainability. To provide design review and presentation schedule for DCAS-II. To document developed design for test and experimentation.
Engineering Development (FC 6.4)	To aid in the man-machine design of the system for service use based on criteria, requirements and specifications determined during Advanced Development. Included are detailed design of equipment panels, packaging and mounting characteristics and room arrangement, cable and duct routing and accessibility features. To assist in finalizing specifications for the system/equipment for service use. To document design characteristics germane to ease of equipment/system operation and maintenance. To provide design review and presentation vehicle for DCAS-IIB. To aid in developing preliminary installation, operation and maintenance procedures and resources.
Operational Systems Development (FC 6.6)	To refine and finalize installation procedures and to familiarize installation personnel with those procedures. As a tool for reconfiguration management and control. To familiarize operational and maintenance personnel with the system. As a training aid for operators and maintainers.
Management and Support (FC 6.7)	As a continuing configuration management and control tool. To facilitate identification of design modifications and improvements. As a training aid.

The M&M can assist the man-machine analysts and designers in accomplishing these tasks as follows:

o Visualization of the physical system, interrelationships, and locations of work-stations.

o Examination of the system or equipment in terms of distances between personnel and equipment and between personnel and other personnel; viewing angles; and access to equipment components, controls and displays.

o Analysis of data in terms of the nature and number of vocal, visual and tactile linkages between personnel and personnel and equipment, and suggesting ways of shortening and consolidating these links through equipment relocation. For example, consolidation of work-stations or console equipments and controls and display may be indicated and a full-scale integrated console may be constructed and various configurations evaluated together with operational personnel.

o Preparation of specifications and drawings for construction of the actual unit(s).

M&M can also assist in developing an equipment design for ease of maintenance; for example, the proposed system components such as chassis, modules, or printed circuit boards can be simulated using foam board, wood or plastic materials. Various physical location and arrangement possibilities can be examined from the standpoint of visual and physical access for maintenance.

For new designs, it is important that the M&M interaction studies begin sufficiently early in the design phase to avoid costly retrofits and to assure that operability and maintainability features will be incorporated into the design prior to design freeze.

MODEL AND MOCKUP CHARACTERISTICS AND SPECIFICATIONS

Models and mockups can be constructed to simulate objects with various degrees of realism. The intended use of the M&M, which is strongly influenced by the particular phase of the design development cycle, often dictates the degree of simulation or realism. To avoid unnecessary expenditures, the M&M should be no more elaborate or complex than necessary to determine the adequacy of sizes, shapes, locations, arrangements of equipments, controls and displays, and other intended uses of the M&M. The characteristics of the M&M in terms of type, scale, degree of simulation and detail, finishes, etc., should be jointly determined by the designer/analyst and the sponsor to ensure that the most cost-effective M&M will be procured. This procedure also provides the model-maker with the M&M specifications. Appendix A is a checklist which lists most of the M&M characteristics to be considered. An M&M specification can then be prepared from the completed checklist. Some examples of M&M specifications are presented in Appendix B.

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APPENDIX A

MODEL AND MOCKUP REQUIREMENTS CHECKLIST

APPENDIX A

MODEL AND MOCKUP REQUIREMENTS CHECKLIST

A model and mockup checklist has been developed to assist the man-machine system designer and sponsor in determining the requirements for the M&M in terms of the items to be constructed, materials to be used, level of detail, etc. The checklist can then be used to prepare a specification for the model/mockup maker. Examples of M&M specifications are presented in this appendix.

MODEL AND MOCKUP CHECKLIST

SCALE AND DIMENSIONS

- ☐ Full-scale
- ☐ Reduced-scale: ☐ 1:12 ☐ 1:24 ☐ ____
- ☐ Two-dimensional
- ☐ Three-dimensional

EQUIPMENT CONSTRUCTION

Equipment Shells: ☐

- ☐ Unit ☐ Component Blocks
- ☐ Rectilinear ☐ Shaped Blocks
- ☐ Representative ☐ Actual Mounting

Panel Faces of Equipment:

- ☐ Fixed ☐ Removable
- ☐ Tape ☐ Adhesive ☐ Magnetic Backing

Elements of Equipment Panel Faces:

- ☐ Fixed ☐ Removable
- ☐ Two- ☐ Three-dimensional Attachments
- ☐ Representative ☐ Actual Switches, Knobs, Display Scopes, etc.

Material:

Construction:

- ☐ Cardboard
- ☐ Foamboard
- ☐ Wood
- ☐ Plexiglass
- ☐ Metal
- ☐ Moldings or Castings

Fastening:

- ☐ Adhesive Tape
- ☐ Glue
- ☐ Magnetic Tape
- ☐ Magnets
- ☐ Pins
- ☐ Dowels
- ☐ Inserts
- ☐ Machine Screws

Level of Detail of Faces of Equipment Panels:

- ☐ Painted ☐ Plain Faces
- ☐ Color
- ☐ Line Drawings ☐ Photographs ☐ Xeroxed Faces
- ☐ Representative ☐ Actual Faces

Additional Detail:

- ☐ Chairs ☐ Desks ☐ Tables ☐ Wastebaskets ☐ Paper Storage ☐ Other
- ☐ Human Figures: ☐ Sitting ☐ Standing
- ☐ Coffee Mess ☐ Galley ☐ Other Hotel Services
- ☐ Fire Extinguishers ☐ Fire Axe
- ☐ Other: _____

Level of Simulation:

Degree of Realism:

- ☐ All Components ☐ Some Components _____
- ☐ All Aspects ☐ Some Aspects _____

Controls:

- ☐ Movement: ☐ Toggle Switch ☐ Rotary Knob ☐ Keyboard Push ☐ Other
- ☐ Effects Produced: ☐ On/Off ☐ Change Information ☐ Change Display

Displays:

- ☐ Lighted ☐ Back-Lighted
- ☐ Photos
- ☐ Slides
- ☐ Viewgraphs
- ☐ Overlay Combinations
- ☐ Movies
- ☐ Video ☐ Depiction
- ☐ Simulated ☐ Actual Depiction (of radar returns, etc.)
- ☐ Audio
- ☐ Other

EQUIPMENT HOUSING CONSTRUCTION

Shelter Design:

- ☐ Permanent ☐ Collapsible Walls (portability)
- ☐ Modular Sections (for reconfiguration of sections
- ☐ Removable: ☐ Top ☐ Side(s) ☐ End(s) ☐ Deck
- ☐ Movable Bulkheads
- ☐ Connectors for Joining Shelters/Compartments/Rooms

Material:

- ☐ Cardboard
- ☐ Foamboard
- ☐ Wood
- ☐ Plexiglass
- ☐ Metal
- ☐ Moldings or Castings
- ☐ Other

Fastening:

- ☐ Adhesive Tape
- ☐ Glue
- ☐ Magnetic Tape
- ☐ Magnets
- ☐ Pins
- ☐ Dowels
- ☐ Inserts
- ☐ Machine Screws

Level of Detail:

Interior Detail:

- ☐ Electrical Conduits
- ☐ Lighting
- ☐ Air Conditioning Ducts
- ☐ Junction Boxes
- ☐ Deck Gridlines: ☐ 12" Intervals ☐ 6" Intervals ☐ 1" Intervals
- ☐ Fixed ☐ Removable Plastic Wall Cover with Details
- ☐ Transparent ☐ Painted Plastic Wall Cover with Details

Walls and Overhead:

☐ Painted ☐ Translucent

☐ Color

☐ Sides ☐ Ends Treated

☐ Line Drawings ☐ Photographs of Shelter Details

☐ Representative ☐ Actual Wall Details

Environmental Control Units:

☐ Painted ☐ Transparent Blocks

☐ Line Drawings ☐ Photographs of ECUs

☐ Representative ☐ Actual ECU Detail

Door:

☐ Flush ☐ Fastened on Door

☐ Painted ☐ Translucent Door

☐ Line Drawings ☐ Photograph of Door

☐ Representative ☐ Actual Door Detail

Support Shelters and Equipment:

☐ Generators

☐ Supply Van ☐ Storage

☐ Cable Reels

☐ Trailer Mount

CONSTRUCTION COMPLETION:

Base:

☐ Platform Details: ☐ Plain ☐ Simulated Field Emplacement

☐ Materials: ☐ Wood ☐ Metal ☐ Plexiglass

☐ Color

☐ Size and Thickness

Nameplate:

☐ Size

☐ Color

☐ Title Wording

☐ Subtitle or Explanation

☐ Logo

☐ Typeface

☐ Printing: ☐ Black ☐ White

☐ Stand or ☐ Frame

☐ Location on Model Base

Equipment Labels:

- ☐ Title Wording: ☐ Name ☐ Number ☐ Function
- ☐ Lettering: ☐ Typewritten on Transparent Tape
  ☐ Embossed Letters ☐ Printed Letters
- ☐ Location: ☐ On Equipment ☐ Top ☐ Side ☐ Bottom
  ☐ On Shelter Wall ☐ On Model Base

Carrying Case:

- ☐ Size
- ☐ Weight
- ☐ Material
- ☐ Handles
- ☐ Wheels
- ☐ Lock
- ☐ Color
- ☐ Labelling
- ☐ Model: ☐ Assembled ☐ Disassembled for Transport

DOCUMENTATION AND SUPPORT ITEMS:

Multiple Models:

- ☐ Additional Equipment
- ☐ Duplicate Copies of All Equipment and Shelters

Visual Support:

- ☐ Viewgraphs of ☐ Model ☐ Actual System
- ☐ Photographs of ☐ Model ☐ Actual System
  ☐ Black and White ☐ Color
  ☐ Slides ☐ Prints
- ☐ Videotapes

Document Support:

- ☐ Map for Replacement or Repositioning of Equipment
- ☐ Blueprints
- ☐ Videotape Book Report

Videotapes:

- ☐ Briefing Tape Summary:
- ☐ Model Description
- ☐ System Description using ☐ Model ☐ Actual Equipment
  ☐ Operations ☐ Maintenance

☐ Actual Equipment in Use

☐ Normal Operations ☐ Degraded Mode

☐ Actual Equipment ☐ Problems ☐ Improvements

☐ Analysis of System Improvements via Models

☐ Training and Familiarization Aid:

See Above.

☐ Degree of Finish to Video: (☐ Working Tapes versus

☐ Presentation Tapes)

☐ Editing

☐ Titling ☐ Insert Frames ☐ Superimpose

☐ Dubbing ☐ New Soundtrack ☐ Superimposed Soundtrack

☐ Script: ☐ Written ☐ ad lib

☐ Videotape Book Report:

☐ Outline

☐ Logging

☐ Script

☐ Still Photos

SYSTEM/EQUIPMENT DATA AND INFORMATION REQUIREMENTS:

Equipment:

☐ Existing ☐ Nonexisting

☐ Blueprints:

☐ Provide ☐ Search

☐ Scale ☐ No Scale

☐ Accurate ☐ Not Accurate

☐ Standard ☐ Modified

☐ Current ☐ Prior ☐ Future

☐ All Plans and Elevations: ☐ Present ☐ Missing

☐ Equipment Depicted: ☐ In Racks ☐ Individually

☐ Actual Measurements of:

☐ Location

☐ Contact: ☐ Name

☐ Phone Number

☐ Date Information Needed

Equipment Housing:

☐ Existing ☐ Nonexisting

☐ Blueprints:

☐ Provide ☐ Search

☐ Scale ☐ No Scale

☐ Accurate ☐ Not Accurate

☐ Standard ☐ Modified

☐ Current ☐ Prior ☐ Future

☐ All Plans and Elevations: ☐ Present ☐ Missing

Actual Measurements:

☐ Location

☐ Contact: ☐ Name

☐ Telephone Number

☐ Date Information Needed

Photo Detail:

☐ Photos to be taken

☐ Date Photos must be Obtained of ☐ Equipment

☐ Equipment Rooms/Compartments

Finishing Construction:

☐ Nameplate Title Wording

☐ Equipment Labelling

☐ Date Information Needed

APPENDIX B

EXAMPLES OF MODEL AND MOCKUP SPECIFICATIONS

SPECIFICATION

FOR

REDUCED SCALE MODEL OF TRIDENT
RADIO COMMUNICATIONS SPACES AND EQUIPMENT

1. General

This specification covers the requirements for the construction of a Reduced Scale Mock-up (RSM) of the TRIDENT radio communications spaces and equipment.

2. Scale

The scale of the mock-up shall be 1/12, i.e., 1" = 1'-0".

3. Description of Mock-up

The mock-up shall be constructed to show space boundaries of the communications center (integrated radio room) including deck, bulkheads, and overheads excluding overhead items such as ducts, cable troughs, lighting fixtures, etc., which may be specifically called out at a later date.

Other items to be constructed include: (1) obstructions or protrusions such as stanchions, columns, piping, etc., (2) selected radio communications equipment racks, consoles, and bulkhead mounted equipments as identified on drawings, and (3) furniture such as tables, desks, chairs, filing cabinets, safes, workbenches, etc.

Simulated hatches, doors, and message passing windows shall be semi-permanently affixed to the compartment bulkheads, deck, etc.

4. Materials

Materials used shall be such as to achieve maximum economy in construction consistent with necessary rigidity, durability, protection, and freedom from distortion. A suggested list of materials follows:

Deck - Plywood and sheet steel to magnetically retain models of equipment and furniture.

Bulkheads and Overhead - Clear acrylic plastic (CAP).

Equipment Items and Furniture - CAP (hollow or solid as appropriate) or where most practicable, relatively hard wood.

Other Items - As agreed upon.

5. Painting

All items shall be painted as follows:

Furniture and Non-equipment Items: Green

Deck and Equipment: Grey

6. Equipment Front Panels

Front panel drawings of equipments shall be reduced to 1/12 scale and attached to racks and consoles by means of magnetic tape and metallized construction paper. Scale photographs of equipment front panels may subsequently be furnished for attachment to the models.

7. Deck Marking

One foot, i.e., one inch grid lines shall be drawn on the painted sheet steel deck using india ink.

8. Magnetic Material

All deck mounted items shall be provided with magnetic tape on the base for retaining these items to the deck.

9. Equipment Model Detail

Equipment models shall be reproduced only in terms of the general shape and major outline dimensions, i.e., no chassis handles, connector plug protrusions, etc. Major teletype equipment curvatures and sloping keyboards shall be included on the models.

10. Message Passing Facilities

Message passing facilities such as passing windows, scuttles, and tubes shall be included in the mock-up. Passing windows requiring physical security

protection shall be identified as to type, i.e., secure on non-secure.

11. Identification

Each item of equipment shall be identified with a number keyed to same on assembly drawings. Dymo tape shall be used and attached at the center rear of the model's top surface. A nameplate titled "TRIDENT Integrated Radio Room" shall be attached to the rectangular base and protected by a clear plastic overlay.

12. Base and Hull Construction Details

(a) Base - The base shall be rectangular with a 1½" border extension.

(b) Bulkheads - A continuous surface representing the hull shall not be provided because of cost and difficulty. All stringers shown on the shipbuilder's drawings shall be constructed and attached to the vertical bulkheads. These stringers shall be made of CAP. A curved plastic footing shall be used to provide the base for the stringers. The vertical bulkheads, stringers, and stringer footing shall be constructed as a single integral unit.

13. Reference Drawings and Equipment List

To be supplied.

14. Schedule

The completed model is to be delivered by

Development Specification for AEGIS Mockups

TABLE OF CONTENTS

DEVELOPMENT SPECIFICATIONS FOR MOCKUPS

1.0 SCOPE

This specification establishes the design and fabrication requirements for mockups of the AEGIS segments as required for the Human Engineering and Systems Engineering Design as described in the System Engineering Program Plan. The primary purposes of the mockups are to assist in the development of space arrangements during detail design and optionally to use as a production tool during construction. The effect on operating personnel should be given prime consideration throughout the development of arrangements as displayed in mockups. The ultimate objective is to assure an optimum arrangement of equipment, fixtures, and other installed materials within allocated spaces and stations with particular attention to:

a. Operational concepts of the station or space (functions to be performed)

b. Safety features

c. Operating personnel habitability

d. Optimum arrangement of equipment, control devices, and other operating facilities

e. Equipment environmental controls

f. Accessibility for ease of maintenance and repair

g. Methods of installing/removing equipment from spaces for maintenance or replacement

h. Elimination of or consideration of interferences

i. Where required, mandatory physical security requirements

j. Interrelationships of other stations and spaces

The mockups shall be capable of being used as design tools and be capable of rapid update to represent the current state of design. Mockups covered by this specification shall include at least those equipments involving critical operator interfaces (consoles and panels).

2.0 APPLICABLE DOCUMENTS

2.1 Government Documents: The following documents of the issue in effect on contract award form a part of this specification to the extent specified herein. In the event of conflict between documents referenced herein and the contents of this specification, the latter shall be considered the superseding requirement.

Government Military Specifications:

MIL-D-1000 - Drawing Engineering and Associated List

MIL-H-46855 - Human Engineering Requirement for Military Systems, Equipment and Facilities

Government Military Standards:

MIL-STD-129 - Marking for Shipment and Storage

MIL-STD-1472 - Human Engineering Design Criteria for Military Systems, Equipments and Facilities

2.2 Non-Government Documents: The following documents of the exact issue shown form a part of this specification to the extent specified herein. In the event of conflict between documents referenced and the contents of this specification, the latter shall be considered the superseding document.

CDRL Sequence No. 159, System Engineering Program Plan.

AEGIS Human Factors Design Guide, 31 May 1970.

Engineering Development Contract, N00017-70-C-2403 (CPIF/RCA) for AEGIS [formerly called Advanced Surface Missile System (U)].

3.0 REQUIREMENTS

3.1 Item Definition: Three-dimensional, full-scale mockups shall be constructed of equipment involving critical human performance. The mockups to be constructed shall be defined in Paragraph 4.2.2.2 of Book 2, System Engineering Program Plan, CDRL Sequence No. 159. Proposed mockups shall be approved by the procuring activity, prior to fabrication, and shall be kept up to date reflecting design progress and changes.

3.2 Characteristics

3.2.1 Performance: Mockups shall be static, nonfunctional representations of equipment design. They shall be used as design tools and in arriving at appropriate overall equipment configurations based on the analysis of visibility, reach and other anthropometric requirements. They shall also be used in the functional design of the interface, i.e., in selecting suitable means for accomplishing required functions and organizing and arranging the devices to facilitate the operations to be performed. No functional mockups or scale models are included as part of this specification.

3.2.2 Physical Characteristics: The mockups shall be full-scale representations of "current" equipment design. Dimensional tolerances shall be as required to meet the performance requirements of Paragraph 3.2.1. They shall be updated monthly to reflect current state of design and changes thereto.

3.2.3 Compatibility: Every means shall be considered to insure that mockups constructed by or for RCA are compatible with those constructed by or for its subcontractors.

3.3 Design and Construction: The most inexpensive materials practical shall be used for fabrication. These materials shall permit rapid

construction and modification. Controls, displays, and other interface hardware shall be represented by artwork. Selected panels may be mocked-up using actual hardware to demonstrate function and appearance, if these characteristics are not well established through prior applications. The workmanship shall be no more elaborate than is essential to determine the adequacy of size, shape, arrangement, and panel content of the equipment for use by man.

3.3.1 Materials: Materials used in the construction of mockups and mockup models shall be such to achieve maximum economy in construction and maintenance. The structural envelope of the mockup shall be constructed of durable material with sufficient strength and rigidity to support attachments, prevent distortion, and provide protection. The base of the mockup shall be sufficiently strong to support the structure.

3.3.2 Painting: Mockups and their associated models shall be painted at least one coat of paint, colored as proposed for the actual shipboard installation.

3.3.3 Identification: Each item of equipment in the mockup shall be identified. Where size permits, the equipment model shall be labeled with military designation and the equipment nomenclature. Components may be identified by a small identification plate. In addition to the identification specified above, each item of equipment shall be assigned an identifying number corresponding to the number shown on the equipment list of the working drawings. This identifying number shall be displayed on the equipment component or immediately adjacent to the equipment. Where practicable, the number shall be of sufficient size to be visible in photographs of the mockup.

3.3.4 Functional Details: Equipment functional components, parts, and devices (such as switches, scope faces, connector jacks, meters, and pushbuttons) shall be shown and labeled as to function on models displayed in the mockups. These devices shall be shown by means of the use of actual equipments or by means of affixing to the model photographic enlargements or facsimiles. Details (such as meter divisions and scope face markings) need not be shown.

3.3.5 Access Requirements: The space required to fully extend furniture drawers, equipment chassis, console compartment doors, or space required for maintenance or replacement of equipment shall be simulated by diagramming the space required on the deck of the mocked-up space. Alternative means to accomplish these objectives shall be considered and recommendations submitted for approval to NAVSEA.

3.3.6 Foundations and Braces: Within a mockup sufficient detail of foundations, shock mounts, and obstructions to correctly depict actual heights and clearances shall be provided.

3.3.7 Furniture: Mockups of chairs, benches, and similar functional items of furniture shall be constructed with sufficient strength to support personnel.

3.3.8 Lighting Requirements: Adequate lighting for the inspection of a mockup is required.

3.3.8.1 Mockups: The mockup operational and emergency lighting shall be installed in order to determine the suitability of operational lighting conditions. Edge lighting for actual plotting and display boards shall be operable. If the actual boards are not installed, their models shall be lighted as realistically as possible. Where provided, actual switches and switchboards shall be internally or externally lighted as appropriate.

Externally lighted switches and switchboards (actual and models) shall be lighted by means of overhead spotlights. Models of internally lighted switches and switchboards shall be labeled to indicate that each of such devices is internally lighted and a note to this effect shall be recorded on the applicable working drawing. Where possible, the actual lighting intended for general and maintenance purposes shall be instalied and shall be operable. However, the installation of general and maintenance lighting should not delay the construction of the mockup.

3.4 Presentation: Mockups shall be presented for inspection of their operational suitability. Mockup presentations will be sponsored by NAVSEA.

3.4.1 Place of Presentation: Mockups shall be presented at a place to be specified by NAVSEA, normally at the contractor's facility.

3.4.2 Schedule

3.4.2.1 Mockup Availability: Mockups should be available for presentation at or before the 50% point of shipbuilding contract period. The mockup availability shall be such that there will be no delay in the production of working drawings or construction.

3.4.2.2 Government Notification: The contractor shall notify NAVSEA of a mockup availability for presentation. Notification shall allow NAVSEA approximately three months for scheduling the presentation. The availability shall be at such time to allow approximately two additional months for approval after presentation is scheduled.

3.4.2.3 Inspecting Personnel: Personnel data on the representatives designated to attend a NAVSEA sponsored mockup presentation will be provided by NAVSEA. Within three working days following the completion of a NAVSEA sponsored presentation, the contractor shall forward to NAVSEA

a list of persons attending the applicable presentation, giving dates of attendance, name and command (or company) of each attendee.

3.4.3 Contractor Provided Services: Where the contract specifies that the mockup shall be presented at the contractor's facility (see 6.1), the contractor shall provide the inspection party during NAVSEA sponsored scheduled presentations the services as specified below:

a. Have available at the mockup site personnel technically qualified to answer questions on the mockup.

b. Have available at the mockup site copies of the applicable ship specification and NAVSEA-furnished arrangement drawings.

c. Provide personnel to rearrange the mockup as authorized by NAVSEA.

d. Have qualified personnel available to man representative portions of mockups as requested.

e. Provide clerical assistance for taking notes during the presentation and for preparation of inspection reports as required.

f. Provide a conference room in the vicinity of the mockup site.

3.4.4 Final Approval: Mockup final inspections shall be scheduled and presented as specified in this specification. Approval of a mockup arrangement will be promulgated by NAVSEA.

3.4.5 Documentation Changes: Within 30 working days following the completion of a final mockup inspection, the contractor shall update the mockup to conform to the approved arrangement and shall prepare and forward to NAVSEA the following documentation as specified.

a. A list of all specification changes required by the approved mockup configuration.

b. A reproducible of each of the working drawings which were used to construct the mockup, updated to show the approved configuration.

c. Photographs of the approved mockup. Ten copies of each photograph shall be provided.

3.4.6 Photographs: Sufficient photographs shall be taken to record all angles of a mockup. All equipment, equipment components, items of furniture or fixtures, structural interferences, and ancillary devices displayed in a mockup shall be visible within a set of mockup photographs. An attempt should be made to cover as large an area as possible in each photograph in order to limit the number of photographs in a set. Each photographic scene shall be such that at least the identification number is visible to the naked eye or, as an alternative, is superimposed on the photograph. Space identification shall be shown in the photograph or the photograph shall be labeled to identify the space or compartment photographed. All photographed prints shall be 8 inches by 10 inches in size with a glossy finish. Negatives shall be films no less than 4 inches by 5 inches and shall be originals, unless duplicate negatives are required. Negatives shall be sharp enough to produce sharp enlargements 8 by 10 inches. If at all practical, photograph angles shall be such to show equipment scope faces, dials, and switches. Each photographic print shall be labeled to show direction of view, space or compartment, functional area, shipyard or command providing photographic services, and date taken. In addition, the back of each print shall be stamped "OFFICIAL PHOTOGRAPH NOT TO BE RELEASED FOR PUBLICATION". The contractor may retain one print for his files. Prints and negatives sent by mail shall be packaged flat without folding and shall be placed between heavy corrugated board, to prevent damage in handling.

3.4.7 Working Drawings: Working drawings required by this specification shall reflect the demonstrated optimum arrangement as developed by the

mockups and the dimension data obtained therefrom. Contractor prepared working drawings shall comply with MIL-D-1000.

3.4.7.1 Prepresentation: At least 15 working days prior to a NAVSEA sponsored mockup presentation, the contractor shall provide two copies of the mockup drawings. The drawings shall show plan views, and where required for clarity, elevation views of the actual configuration as displayed by the mockup.

3.4.8 Disposition of Mockups

3.4.8.1 Mockups shall be retained at the location where constructed until disposition is authorized by NAVSEA. Such authorization will be issued as soon as practicable after the mockup has served its usefulness.

4.0 QUALITY ASSURANCE PROVISISIONS

4.1 Responsibility for Inspection

4.1.1 Contractor: Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of an inspection to determine compliance with NAVSEA furnished guidance documents, guidance drawings, or applicable ship's specification, as appropriate.

5.0 PREPARATION FOR DELIVERY

5.1 Mockups will be presented at the location where constructed, and no delivery is required.

6.0 NOTES

6.1 Security Classification: Mockups, mockup drawings, and photographs of mockups will be unclassified unless otherwise directed.

APPENDIX C

MODEL AND MOCKUP APPLICATIONS

Table C-1. Model and mockup applications.

*Key: 2D - Two-Dimensional
3D - Three-Dimensional
RSM - Reduced-Scale Model
FSM - Full-Scale Mockup
F - Functional Model or Mockup
EA - Equipment Arrangement
PL - Panel Layout
RA - Room Arrangement
T - Training
O - Other

Sponsor/ User Agency	Model or Mockup Application	Type					Use					Page
		2D	3D	RSM	FSM	F	EA	PL	RA	T	O	
United States Navy	Bathyscaph TRIESTE II Gondola		X	X			X					46
	USS BELKNAP (DLG-26) - Radio Room		X	X			X		X			48
	SSBN-640 Radio Room		X	X			X		X			50
	TRIDENT Radio Room		X	X			X		X			52
	SSN-688 Radio Room	X	X	X	X		X		X			54
	Submarine Noise and Vibration Monitor/Analyzer	X			X			X				56
	TACAMO Communications Compartment		X	X	X		X		X			58
	Shipboard Berthing Spaces		X	X					X			60
	WLR-8 ECM Console		X		X			X				62
	EW "Design to Price" Operators Console		X		X	X		X			X	64
	EDATL		X	X			X		X			66
	Mine Countermeasures Vehicle Maintenance Area		X	X					X			68
	Mine Countermeasures Vessel Maintenance and Deck Areas		X	X		X	X		X	X		70

Table C-1. Model and Mockup Applications (Cont.)

Sponsor/ User Agency	Model or Mockup Application	Type					Use					Page
		2D	3D	RSM	FSM	F	EA	PL	RA	T	O	
United States Marine Corps	AN/TPS-32 Surveillance Radar System		X	X			X		X			72
	Direct Air Support Central (DASC)		X	X					X			74
	Kneeling Trailer Assembly		X	X							X	76
Defense Communications Agency	Emergency Action (EA) Console		X		X			X				78
	National Military Command Center (NMCC) EA Room		X	X					X			80
	Alternate NMCC EA Room		X	X					X			82
	Current Actions Center (CAC)		X	X					X			84
	CAC Watch Officer's Work Station		X		X			X				84
	Deputy Director of Operations (DDO) Room		X	X					X			86
	DDO Work Station		X	X	X		X					86
	Joint Reconnaissance Center (JRC)		X	X					X			88
	JRC Operations Room	X	X	X					X			88
	JRC Watch Officer's Console		X	X	X		X	X				90
	Survivable Command Center		X	X					X			92
	EC-135 Airborne Command Post (ACP)		X	X					X	X		94
	ACP Integrated Record Data System Console		X		X		X	X				96
	E4A Airborne Command Post		X	X					X			98

Table C-1. Model and Mockup Applications (Cont.)

Sponsor/ User Agency	Model or Mockup Application	Type					Use					Page
		2D	3D	DSM	FSM	F	EA	PL	RA	T	O	
Bureau of Medicine and Surgery	Portable Life Support Stretcher		X		X	X	X					100
	Remote Medical Diagnosis System		X		X	X	X	X				102
Civil Engineering Laboratory	Container Offloading and Transfer System (COTS)		X	X						X	X	104
	COTS Jack Control Unit	X			X			X				106
	COTS Causeway Section		X	X							X	108

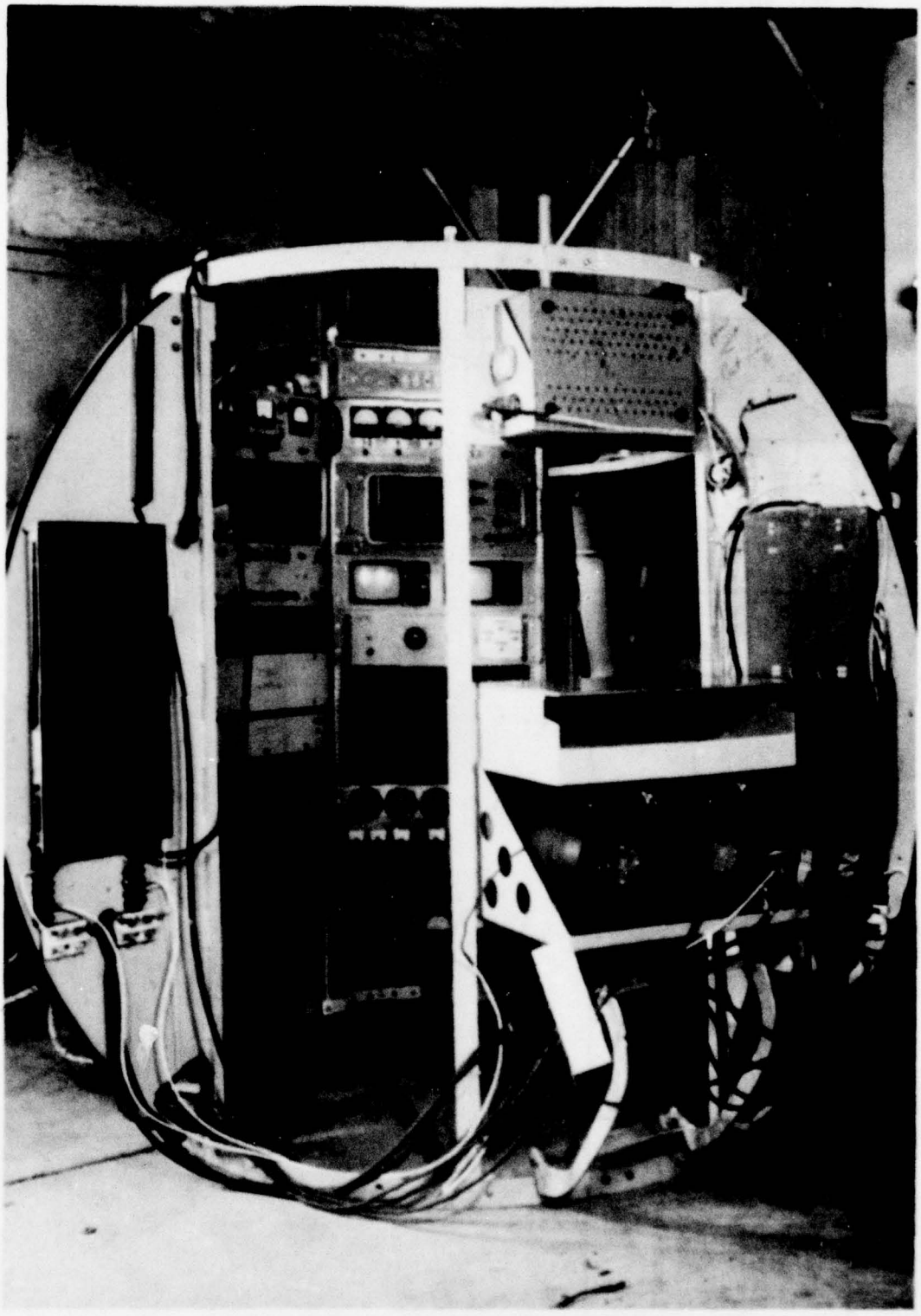


Figure C-1. TRIESTE II bathyscaph gondola.

TRIESTE II BATHYSCAPH -- GONDOLA EQUIPMENT LAYOUT

Objective:

To optimize the arrangement of equipment in the TRIESTE II Bathyscaph gondola for ease of operation and maintenance.

Results:

Pilot and navigator tasks and equipment access requirements were identified. A model of the gondola and equipment to be installed therein was constructed to develop an equipment arrangement that would best satisfy the needs of the pilot and navigator, taking into account constraints imposed by the 6-foot diameter gondola and equipment heights and depths. See Figure C-1.

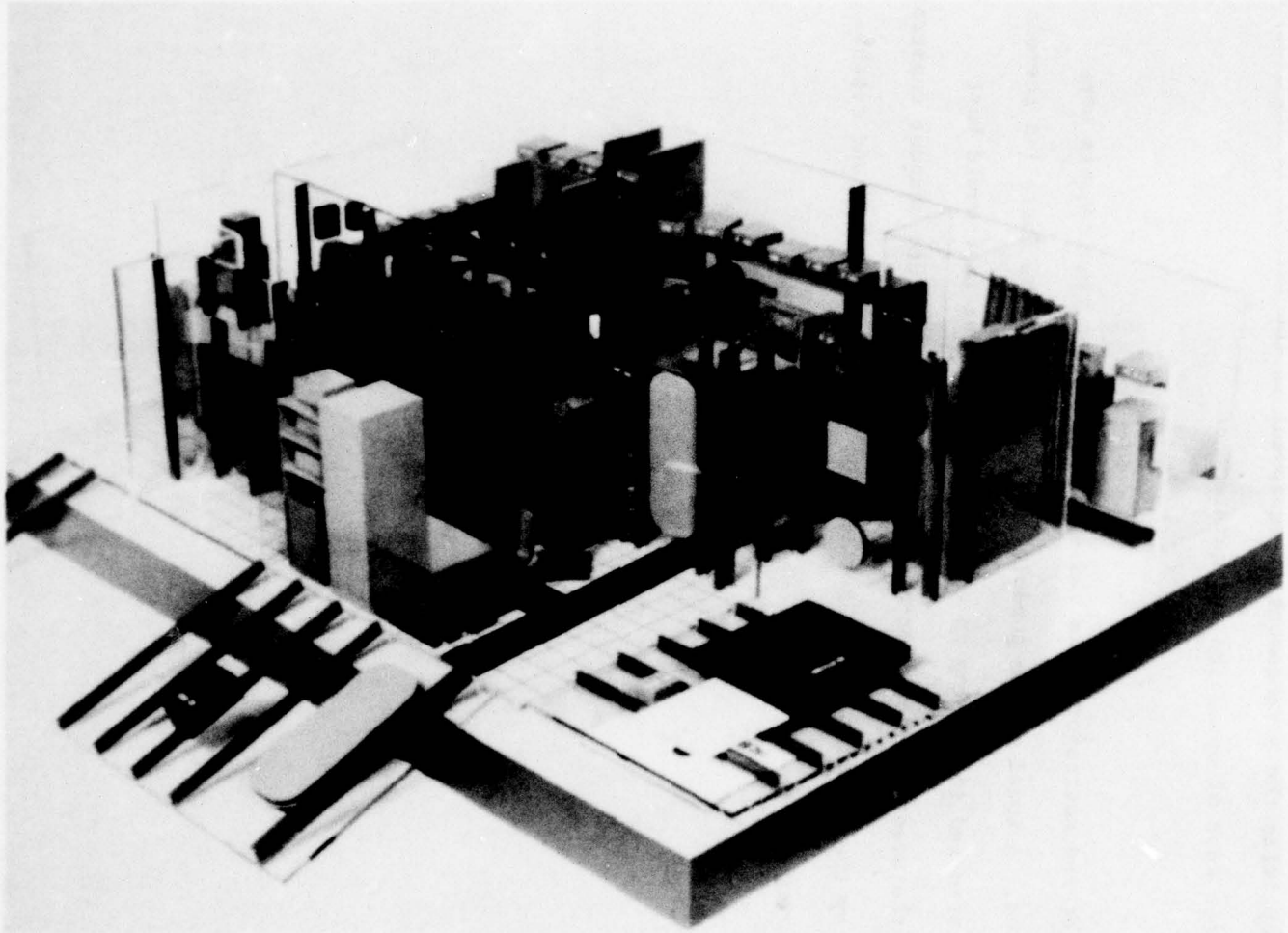


Figure C-2. DLG-26 (BELKNAP) radio communications compartments.

DLG-26 BELKNAP COMMUNICATIONS COMPARTMENTS

Objective:

To develop a layout for proposed radio equipment in the radio central compartments of a DLG-type ship.

Results:

A model of the radio communications spaces and equipment in the DLG-26 was constructed to study activities, personnel movements, and potential problem areas in the areas of equipment control, operation and maintenance as influenced by the layout of equipment in these spaces. This information was used to develop an equipment layout of new radio equipment to avoid or mitigate identified problems in the present system.

See Figure C-2.

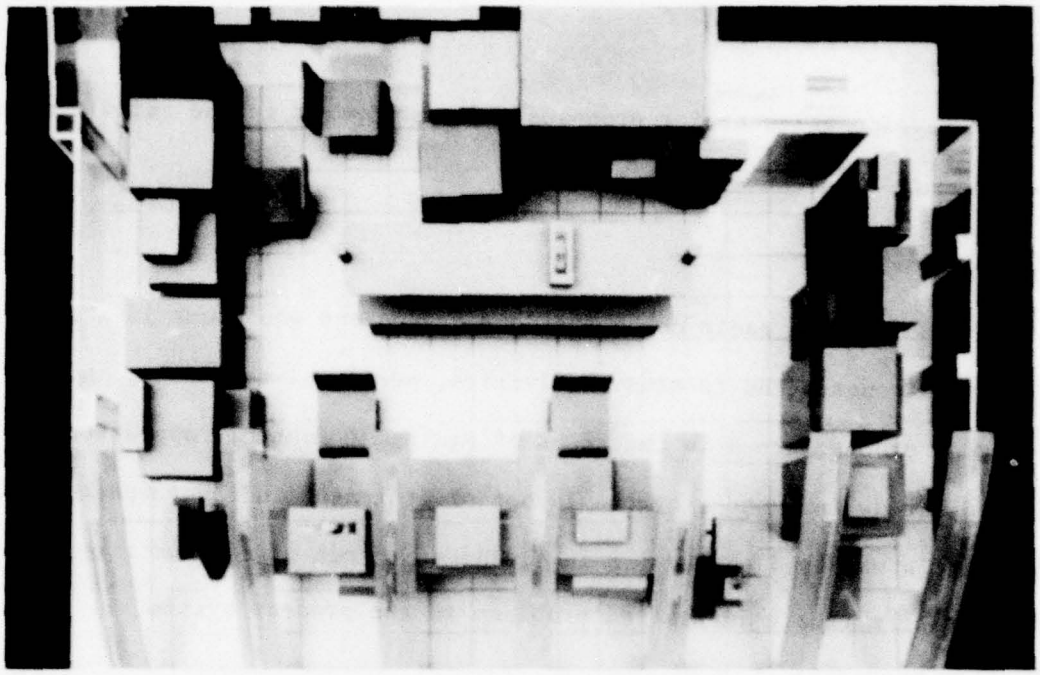


Figure C-3A. SSBN-640 class submarine radio room. Original configuration.

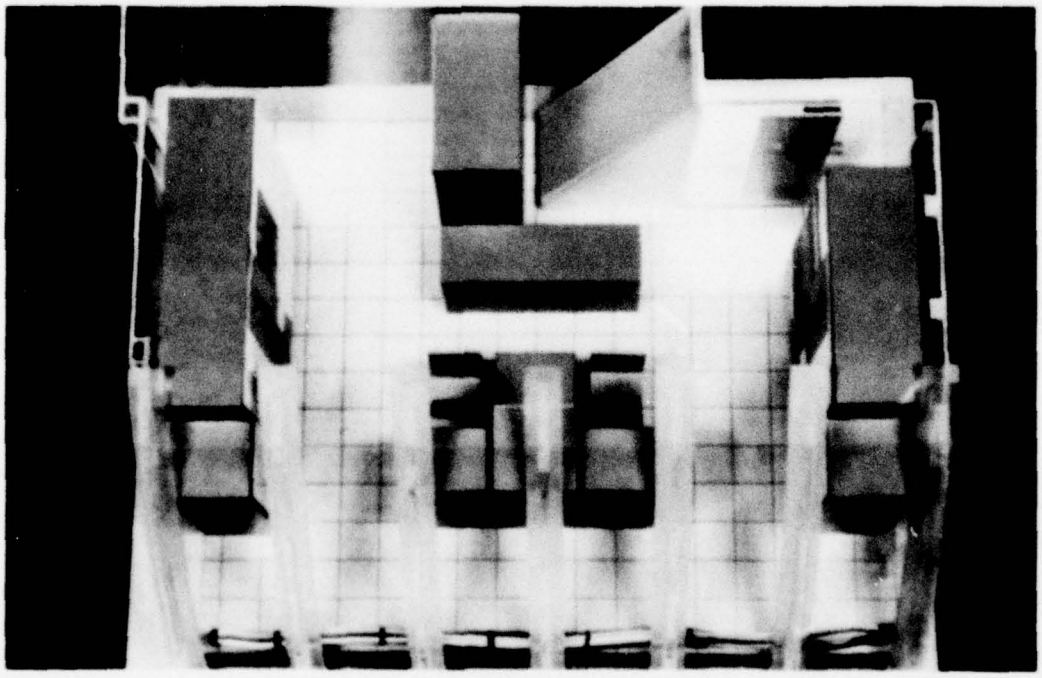


Figure C-3B. SSBN-640 class submarine radio room. Proposed configuration with new equipment.

SSBN-640 CLASS SUBMARINE RADIO ROOM

Objective:

To develop an arrangement for proposed communications equipment in the radio room of the 640 Class submarine from the man-machine interaction standpoint.

Results:

Two models of the radio room and equipments were constructed for the present and proposed systems to develop an equipment arrangement for the suite of new equipment. Operator/maintainer interfaces with the equipment were identified and examined to develop a proposed layout for sponsor and user review and evaluation. The models were found to be very useful in presenting arrangement concepts and associated rationale to sponsors and other interested persons. See Figures C-3A and C-3B.

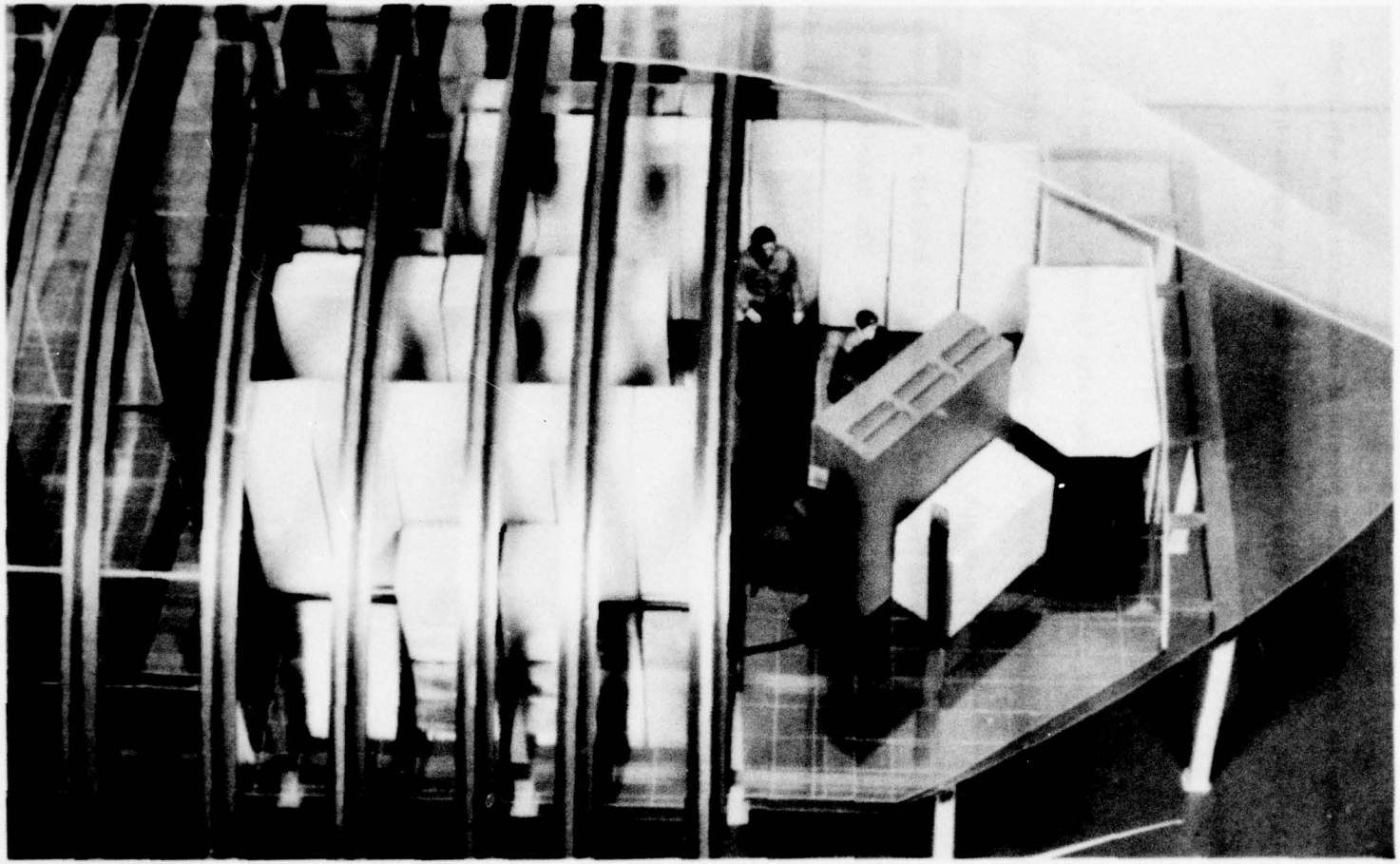


Figure C-4. TRIDENT submarine proposed radio room layout.

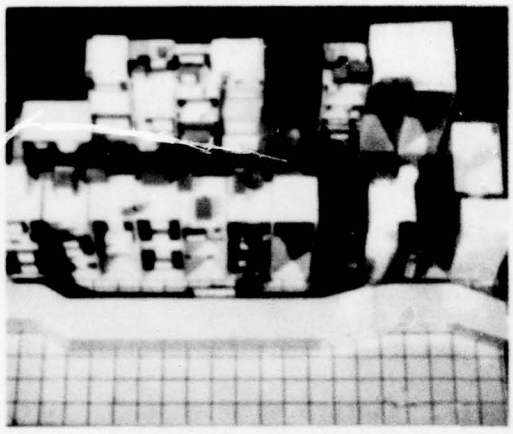
TRIDENT SUBMARINE RADIO ROOM

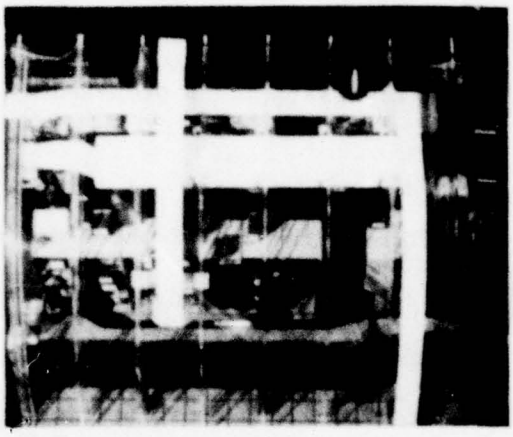
Objective:

To provide an effective means of evaluating TRIDENT radio room equipment arrangements proposed by two competing contractors.

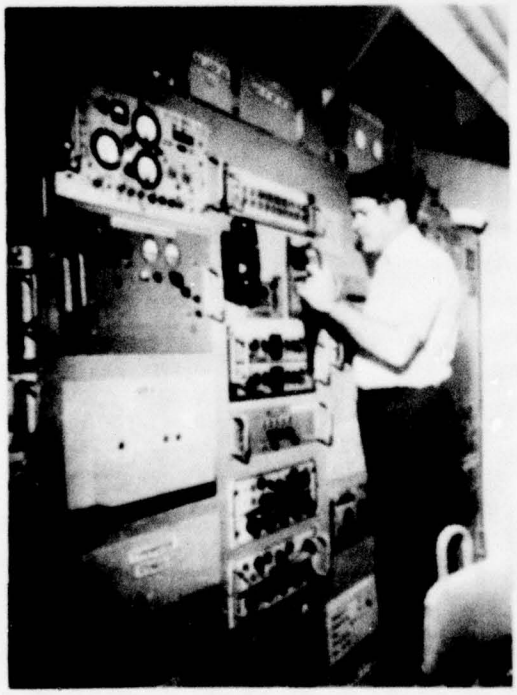
Results:

Through the use of three-dimensional reduced scale models of the radio room and proposed equipments, sponsors and NOSC systems and engineering personnel were able to quickly pinpoint advantages and disadvantages of the two radio room configuration proposals. Factors such as work space, interferences, flow of personnel, and access for maintenance were readily evaluated with the models (Figure C-4).





Figures C-5A and C-5B. SSN 688 submarine radio room. Model of proposed equipment arrangement.



Figures C-5C and C-5D. SSN 688 submarine radio room mockup of proposed equipment arrangement.

SSN-688 SUBMARINE RADIO ROOM

Objective:

To develop an equipment configuration using a mixture of existing and proposed equipment for ease of operation and maintenance and to ensure orderly sequence of installation of new radio room equipments.

Results:

A two-dimensional model of rack elevations was used to develop preliminary alternative equipment locations and to update same as changes were identified. This mockup was also used to document the configurations on a photocopying machine, thus eliminating the need for continual changes to/drawings.

A three-dimensional model of the radio room was used as a tool in determining the possible locations of equipment items as influenced by available rack depth due to hull curvature. This model was subsequently used for guiding construction of a full-scale engineering and operational prototype of the radio/room (Figure C-5A and C-5B).

A mockup of the radio room was then constructed to obtain a realistic visualization of the radio room configuration and to validate and modify it from the operator's standpoint in terms of visual and physical access to controls and displays. The mockup components were then installed in an operational prototype compartment and replaced with actual equipment as they became available. In this way, program and project personnel could visualize the final configuration prior to and during equipment installation. See Figures C-5C and C-5D.

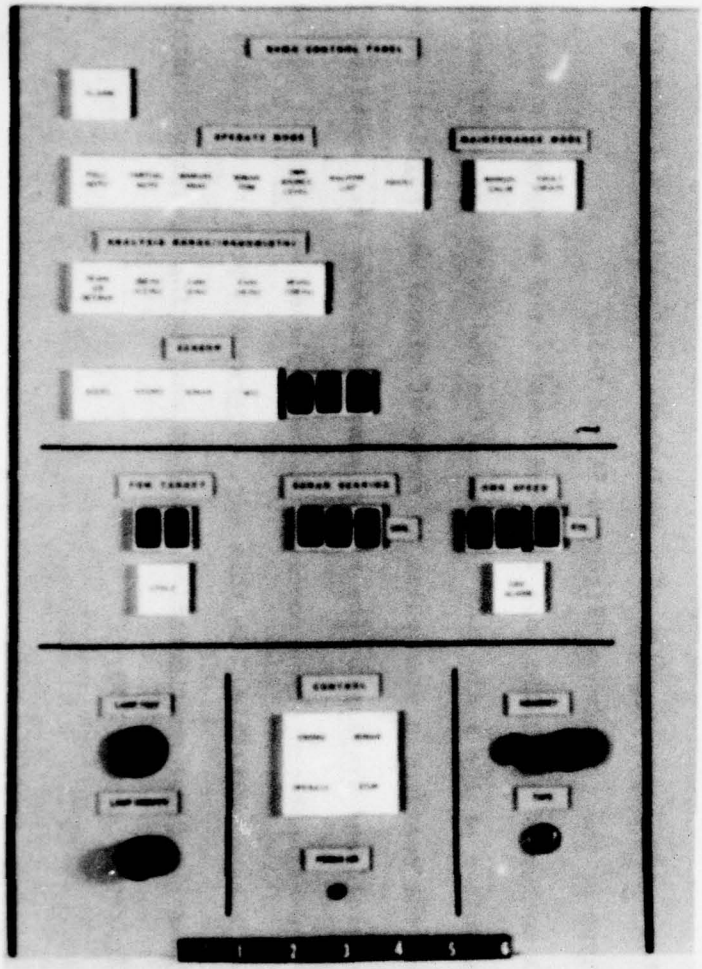


Figure C-6A. Mockup of proposed panel of NVMA.

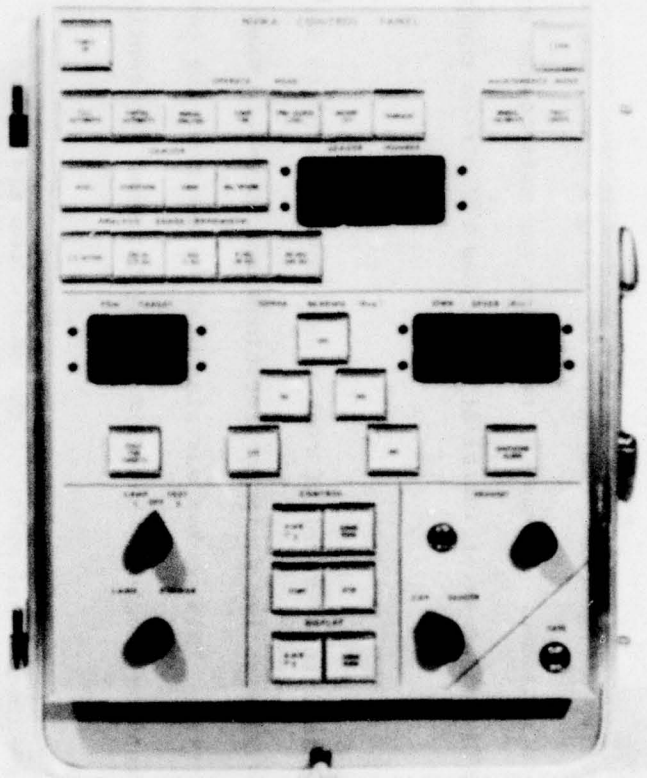


Figure C-6B. Actual front panel of NVMA after final evaluation of mockup.

SUBMARINE NOISE AND VIBRATION MONITOR AND ANALYZER (NVMA)

Objective:

To design a layout of the control panel of the NVMA with emphasis on ease of operation.

Results:

Controls and control indicators were simulated and backed with magnetic tape to semipermanently attach them to any location on a steel panel. In this way, alternative layouts were developed and evaluated to select the preferred arrangement for ease of operation. See Figures C-6A and C-6B.

Figure C-7A. Mockup of TACAMO communication central space.

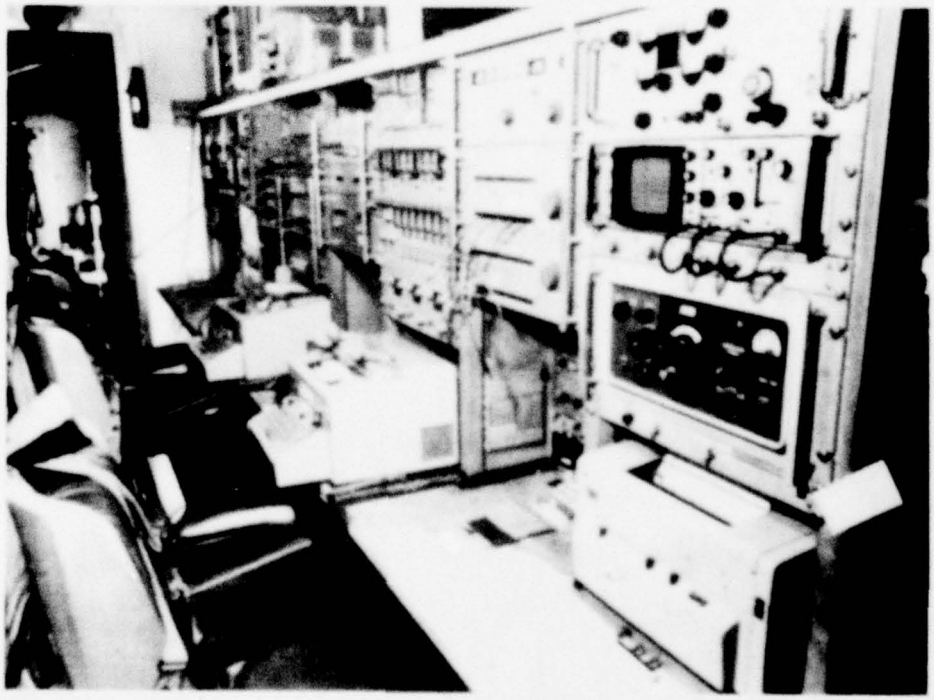


Figure C-7B. Actual TACAMO communication central space.

TACAMO AIRCRAFT

Objective:

To identify man-equipment operation and workspace problems and provide recommendations for overcoming them in a physical layout of a new suite of proposed equipments.

Results:

A mockup of the communications central space of the TACAMO aircraft was constructed, and problems were identified by "walking through" a scenario of equipment operation. A major finding was that the watch supervisor could not effectively monitor activities of communications equipment operators due to equipment separation resulting from an in-line configuration and proximity of the equipment to the aircraft bulkhead. A recommended configuration to overcome this and other visual and physical access problems with new equipment was developed using three-dimensional scale models. See Figures C-7A and C-7b.

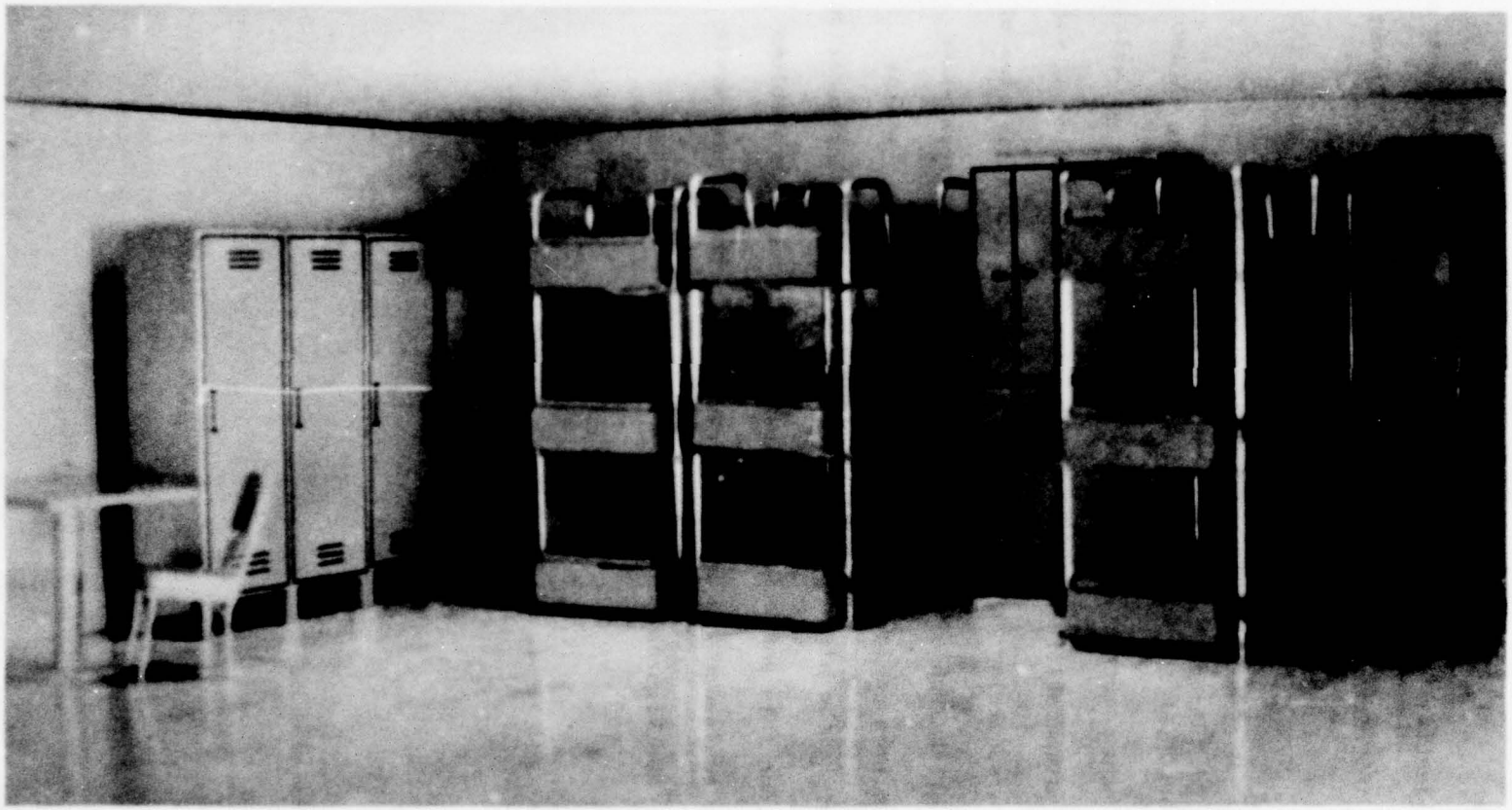


Figure C-8. Model of shipboard berthing space.

UNITED STATES NAVY - HABITABILITY STUDIES

Objective:

To improve the living spaces and work environments of the officers and enlisted personnel aboard Navy ships.

Results:

Three-dimensional models of berthing quarters were developed for ship spaces in general and for the USS SANCTUARY in particular. With these models, different configurations of the bunks and lockers were experimented with as a means of increasing privacy, reducing traffic flow and noise, and increasing convenience of access to lockers and stowage areas.

Two-dimensional models of berthing quarters were used to assess the preferences of Navy enlisted men for different room configurations.

Experimental arrangements of bunks indicated that greater flexibility of design and increased privacy could be achieved if the orientation of the bunks could be altered, specifically, if athwartship as well as longitudinal berthing could be employed. A separate study on the effects of athwartship orientations assembled sufficient evidence to alter the policy of BUMED and NAVSEC to permit a mixture of berthing orientations to be employed. See Figure C-8.

Additionally, three-dimensional models of recreational areas and couches, chairs, etc., were developed to experiment with different color combinations, light sources and levels (incandescent or fluorescent; panel- or spot-lights), wall treatments (plain color, accent walls, wood grain paneling, etc.). Photographs of different treatments were taken and used to assess the preference of Navy enlisted men for habitability arrangements.

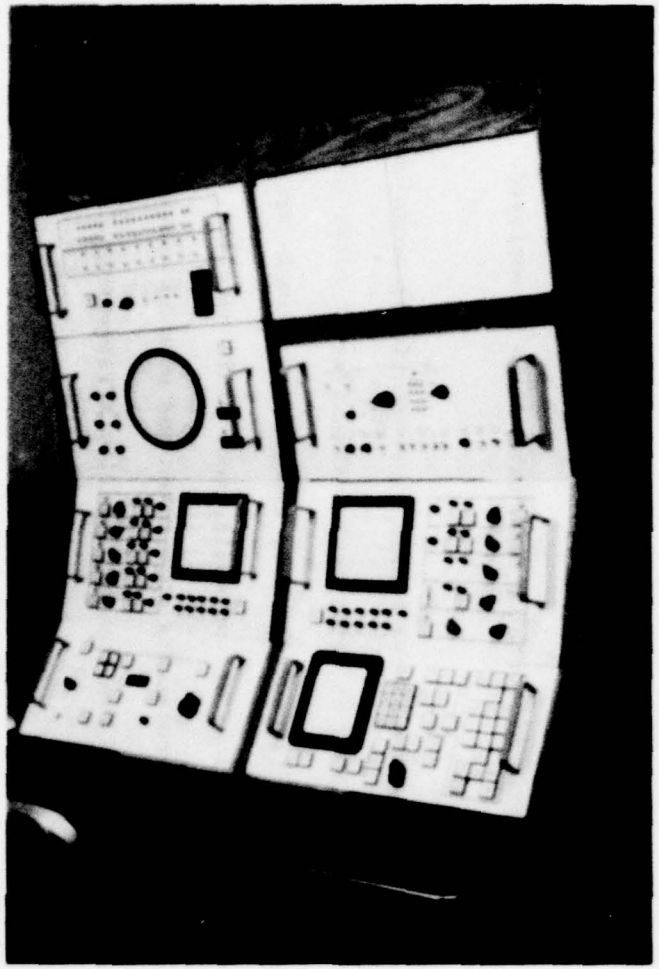


Figure C-9A. Mockup of recommended panel layout for the WLR-8 control console.

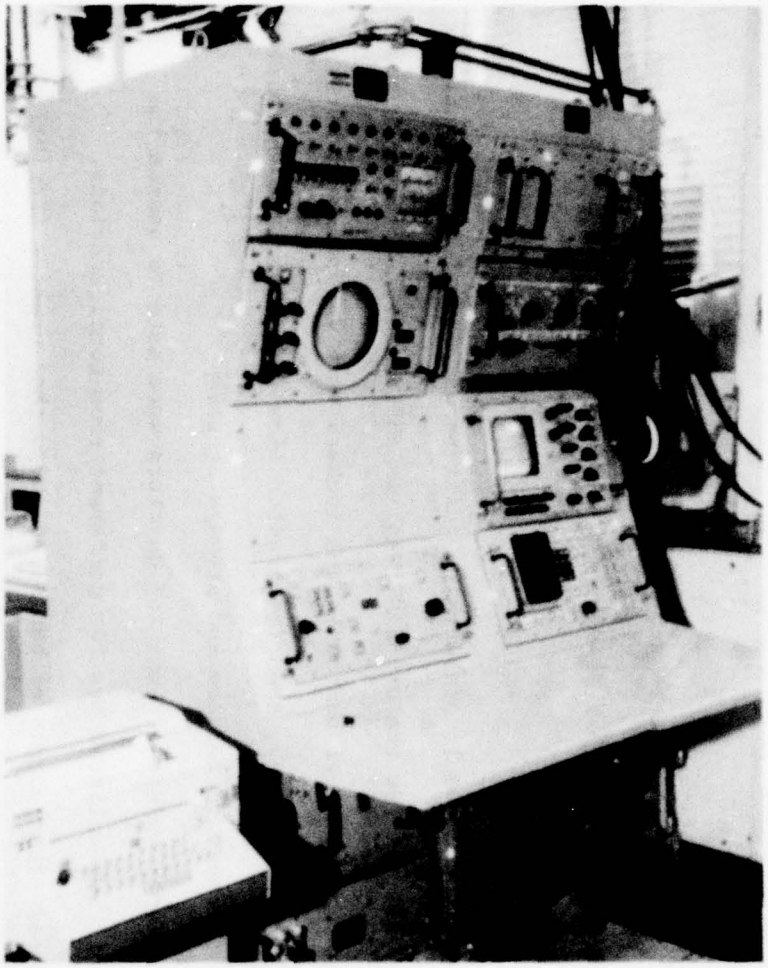


Figure C-9B. Actual WLR-8 control console.

WLR-8 ECM CONTROL PANEL

Objective:

To develop a console and control/display panel arrangement to facilitate operator control and operation of the system.

Results:

A mockup of the console front panels and proposed controls, displays and indicators was constructed to develop an effective layout of these items. All panel components were constructed so as to be readily relocated to any locations on the panels. A design was developed by project personnel and comments obtained from operational personnel. Modifications to the layout were then made and a recommended design was submitted to the sponsor. See Figures C-9A and C-9B.

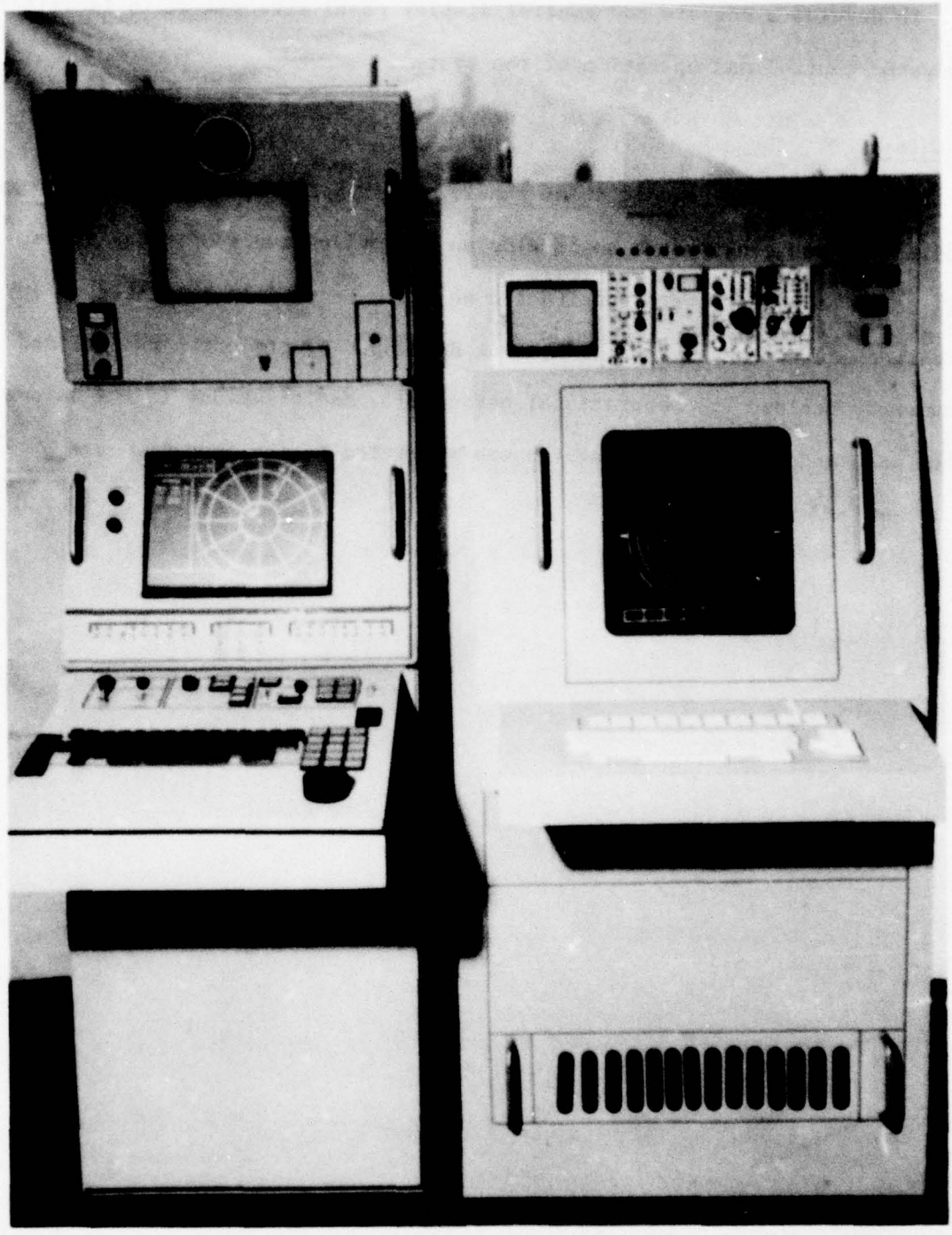


Figure C-10. SLQ-31 and SLQ-32 EW consoles (quasi-functional mockups).

SLQ-31 AND SLQ-32 EW CONSOLES

Objective:

To compare the operational utility of two consoles and display concepts for EW systems developed by two competing contractors.

Results:

Two mockups of the proposed consoles were constructed including simulation of display format sequencing using 35mm slide projectors. Comparative evaluations were then made and used to brief Navy personnel on the operator's role in the systems as well as to familiarize Navy Training Plan Conference personnel with console operational concepts. Available documentation could not have provided this type of information. See Figure C-10.

Figure C-11. Model of recommended arrangement for the experimental command center.

ADVANCED COMMAND AND CONTROL TESTBED

Objective:

To provide design consultation and develop a set of approved specifications for the man/machine interface modular components in the Experimental Command Center (ECC) of the Advanced Command and Control Testbed (ACCAT).

Results:

A model of the four simulated command areas were constructed and specifications for the recommended equipment and arrangement were developed.

In the performance of this task, design review meetings were held with ACCAT personnel and functional and positional evaluations of the display console work station configurations and areas were accomplished. See Figure C-11.

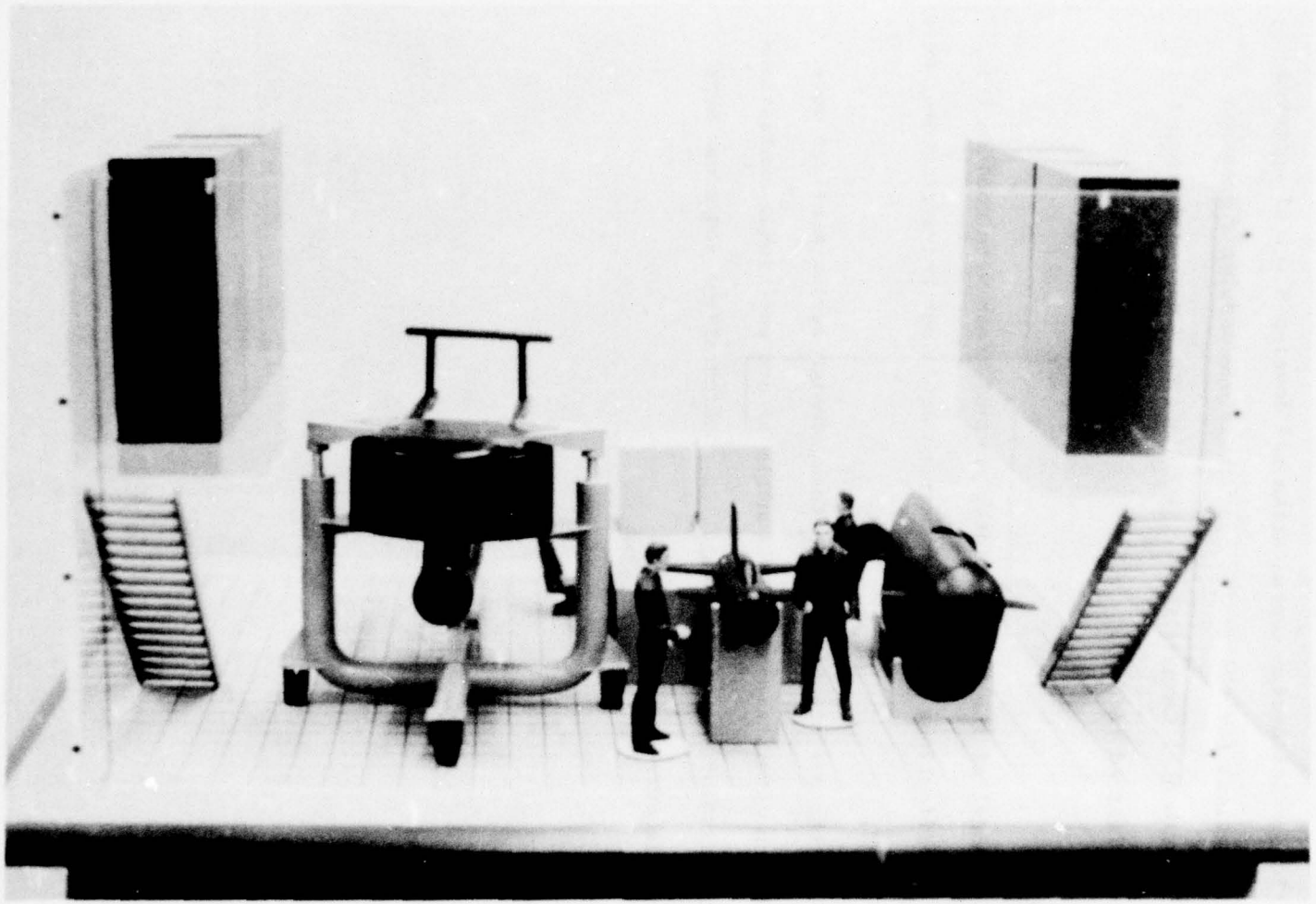


Figure C-12. Model of vehicle maintenance compartment layout for mine countermeasures vessel.

MINE COUNTERMEASURES VESSEL (MCV) - VEHICLE MAINTENANCE COMPARTMENT

Objective:

To develop an arrangement of facilities and equipment in the vehicle checkout and maintenance area of the MCV to facilitate accomplishment of these activities.

Results:

Alternative arrangements of equipment and facilities were developed and evaluated using a three-dimensional model. A preferred arrangement was selected and submitted to the sponsor in the form of photographs of the model and accompanying rationale for the recommended configuration (Figure C-12).

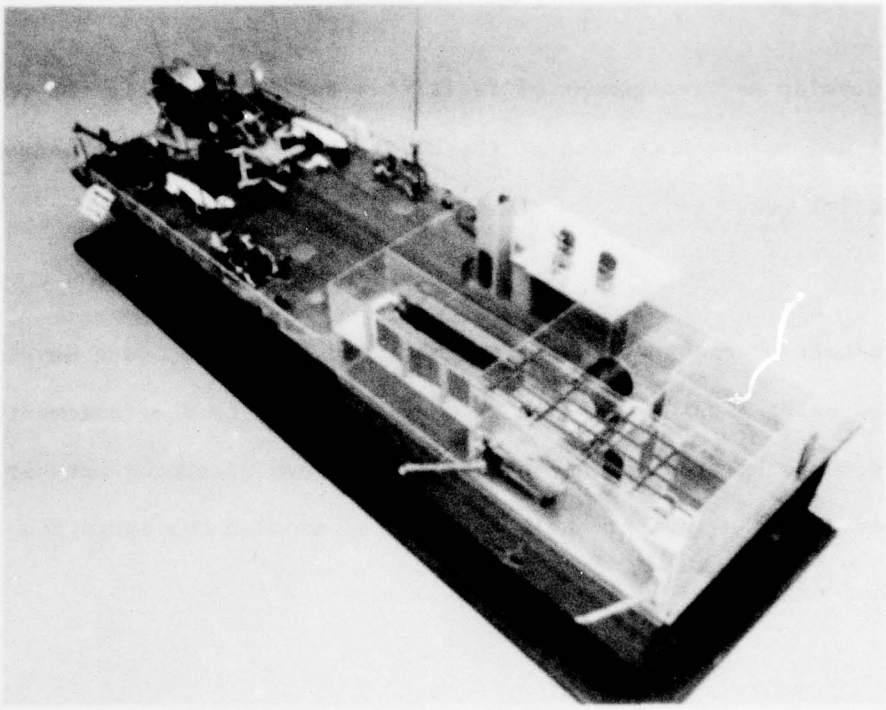


Figure C-13A. Model of MCV maintenance and vehicle handling areas.

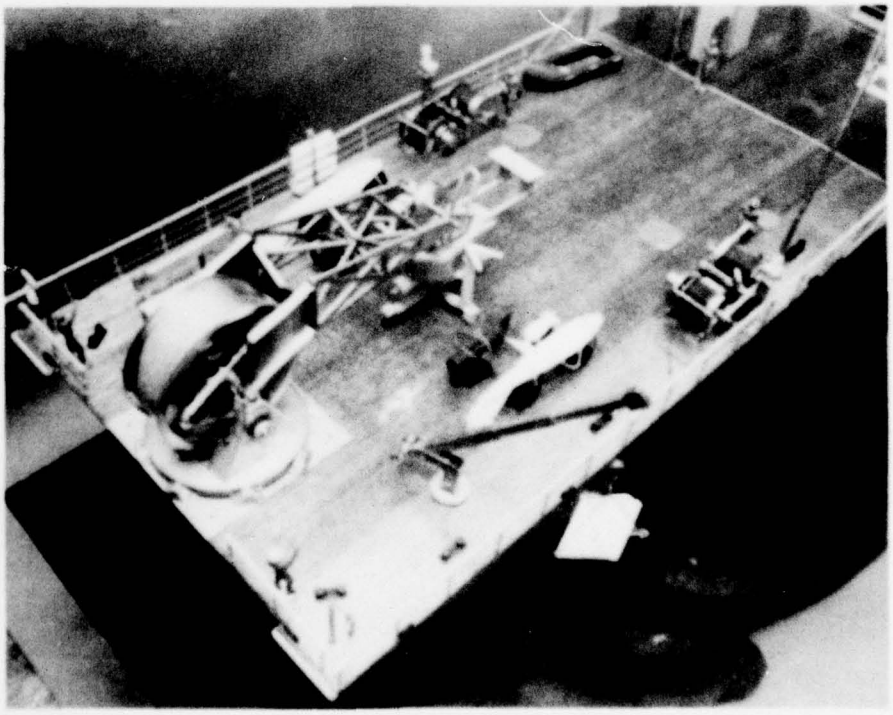


Figure C-13B. MCV model-detail of vehicle handling area.

MINE COUNTERMEASURES VESSEL (MCV) - MAINTENANCE AND DECK AREAS

Objective:

To provide a working model to determine the most effective location of mine countermeasures equipment and associated handling devices.

Results:

The model is currently being used at NAVSEC PMS-300 to study and optimize vehicle launch and recovery activities. See Figures C-13A and C-13B.

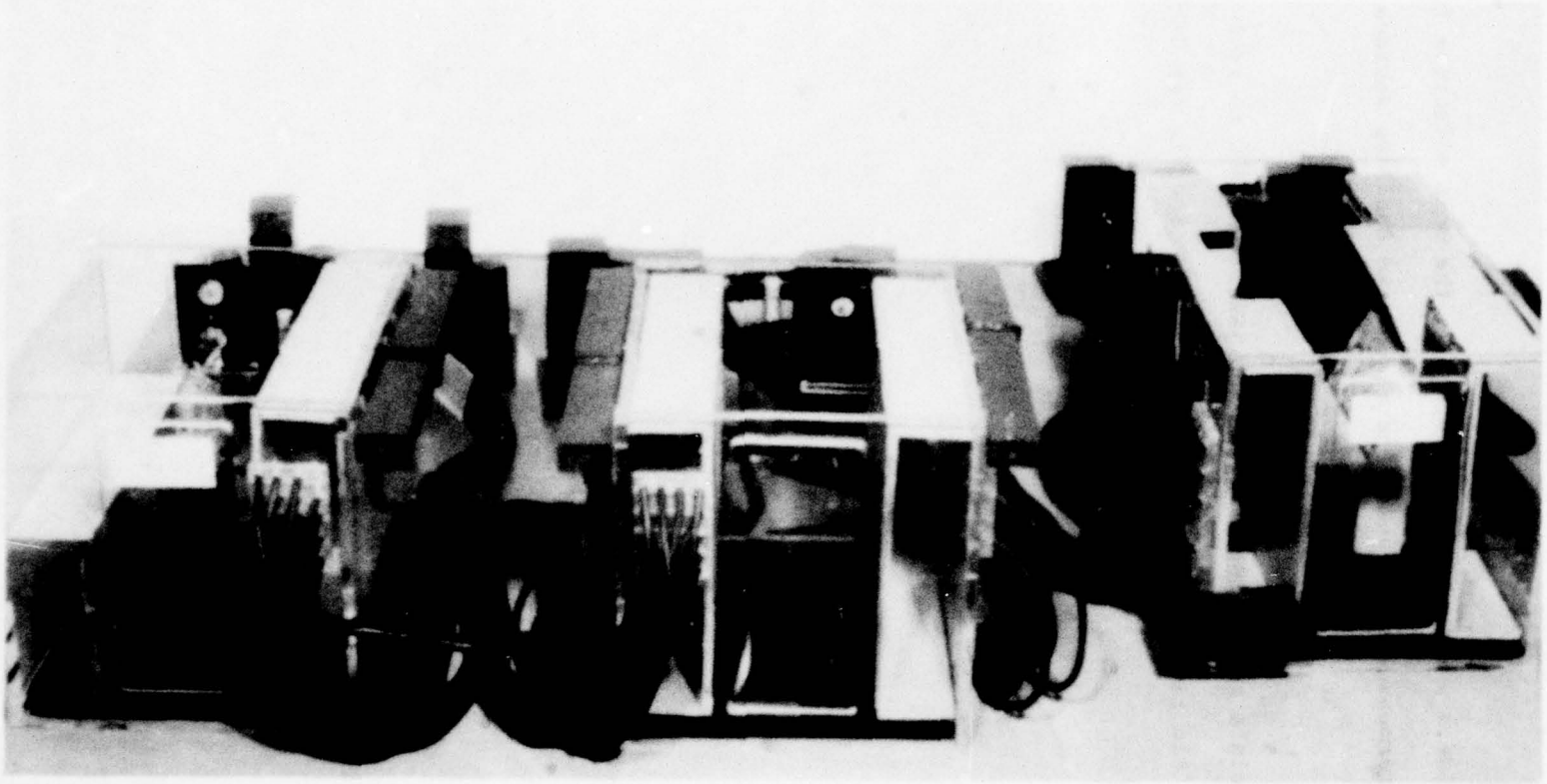


Figure C-14. Model of USMC portable surveillance radar system including air conditioning ducting and cabling.

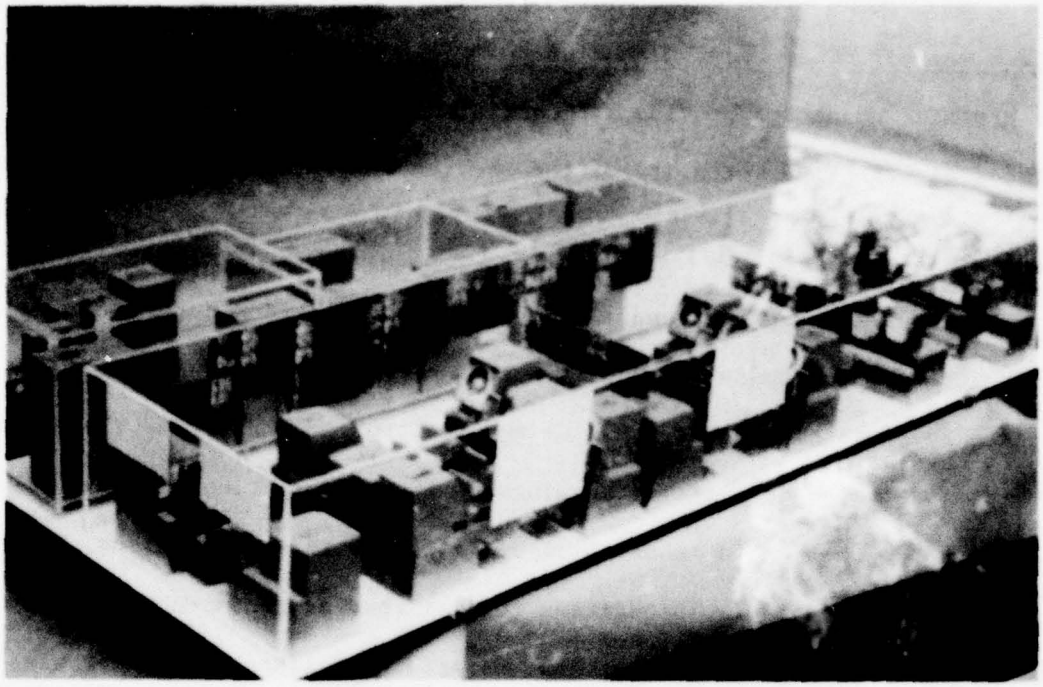
USMC AN/TPS-32 - PORTABLE SURVEILLANCE RADAR SYSTEM

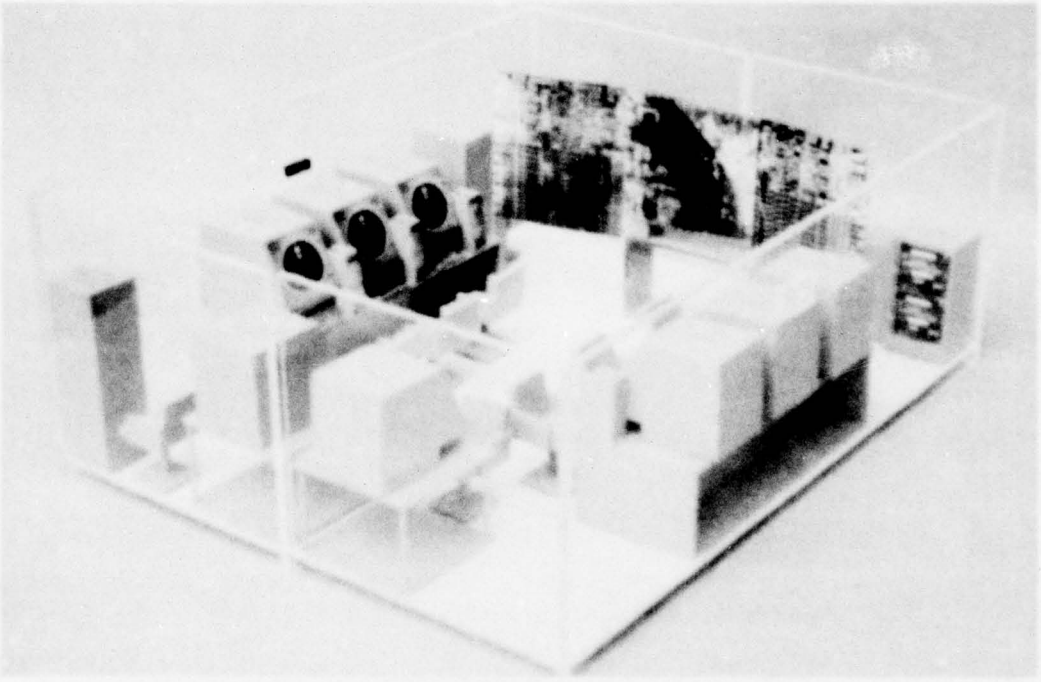
Objective:

Minimize noise and provide air conditioning for equipment shelters without altering the integrity of the shelter, e.g., no drilling of holes.

Results:

Models of the shelters and air conditioning units and ducting were constructed to determine best duct routing method within constraints imposed by physical interferences of and between the shelters. The mockup was also used to verify drawings of the installation and to provide the sponsor with a rapid means of visualizing the three-dimensional aspects of the proposed design. In addition to duct routing recommendation, it was also recommended that noise abatement materials be installed in certain locations (Figure C-14).





Figures C-15A and C-15B. USMC - direct air support central models.

USMC - DIRECT AIR SUPPORT CENTRAL (DASC)

Objective:

To identify problem areas in equipment/shelter/personnel design and interactions and recommend a shelter reconfiguration to overcome these problems. In addition, document existing operating procedures in normal and degraded modes and devise a simulation control shelter.

Results:

DASC operations were viewed and video-taped and interviews were conducted with operators and maintenance personnel. Problem areas were identified and photographed and/or video-taped. A video-tape report was made to identify the system components and operations, to describe each of the operator responsibilities/activities and to demonstrate problems with operating/maintaining the equipment and status boards. A hard-copy report containing an outline text, photographs, and line-drawings was developed to accompany the video-report.

Three-dimensional models of the existing shelters and equipment were constructed to represent the present configuration. Mockups of two standard 8x8x20 shelters with removable side walls were then made to represent the proposed new housing and duplicate copies of the existing equipment were made for installation in the new housing. New configurations for the DASC to be contained in two shelters were then developed.

A three-dimensional model of a standard shelter and of component equipment was developed for a proposed simulation control center. See Figures C-15A and C-15B.

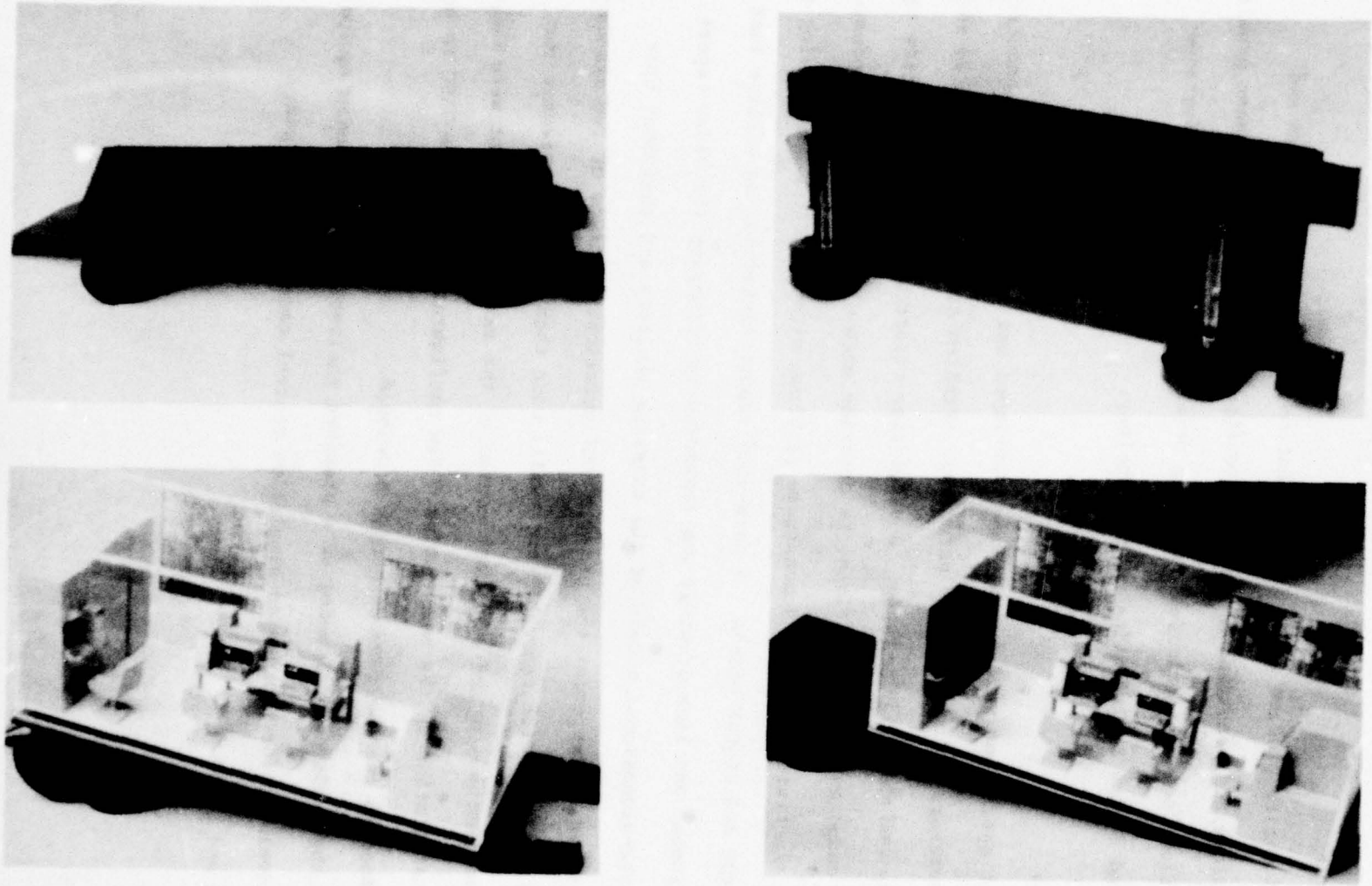


Figure C-16A - C-16D. USMC kneeling trailer mount illustrating operational concept.

USMC - KNEELING TRAILER MOUNT ASSEMBLY

Objective:

To provide a vehicle to demonstrate the concept of a kneeling trailer mount assembly for lowering and raising a shelter onto a trailer.

Results:

A model of a kneeling trailer mount assembly was constructed according to blueprint specifications. The bogie assemblies on the trailer were constructed such that they could be moved forward and backward and the tailgate was articulated so that it could be used as a ramp, a support, or a restraint for the shelter. The reduced-scale model was used to demonstrate the functioning of the kneeling trailer mount assembly. See Figures C-16A, C-16B, C-16C and C-16D.

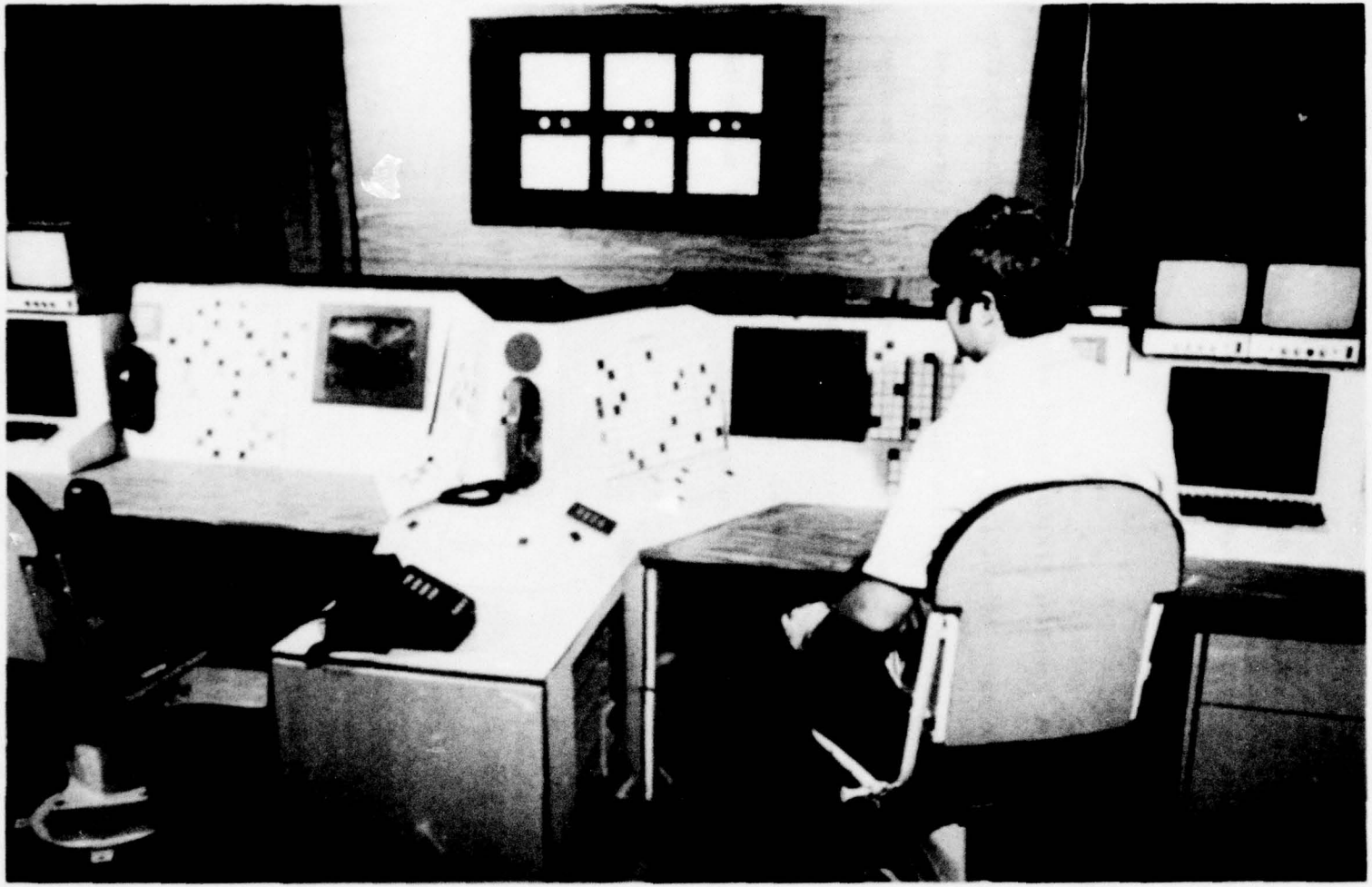


Figure C-17. Mockup of a proposed console for the emergency action room of the NMCC.

NATIONAL MILITARY COMMAND CENTER - PENTAGON

EMERGENCY ACTION CONSOLE

Objective:

To develop an integrated Emergency Action and Communications Officers console and control-display layout which incorporates proposed new console equipment components.

Results:

A mockup of an integrated console was developed taking into consideration the operator's needs and proposed new equipments. Alternative layouts and arrangements of controls, displays, indicators and other components were developed and evaluated. On the basis of these evaluations a recommended configuration for the console and console-mounted components was developed (Figure C-17).

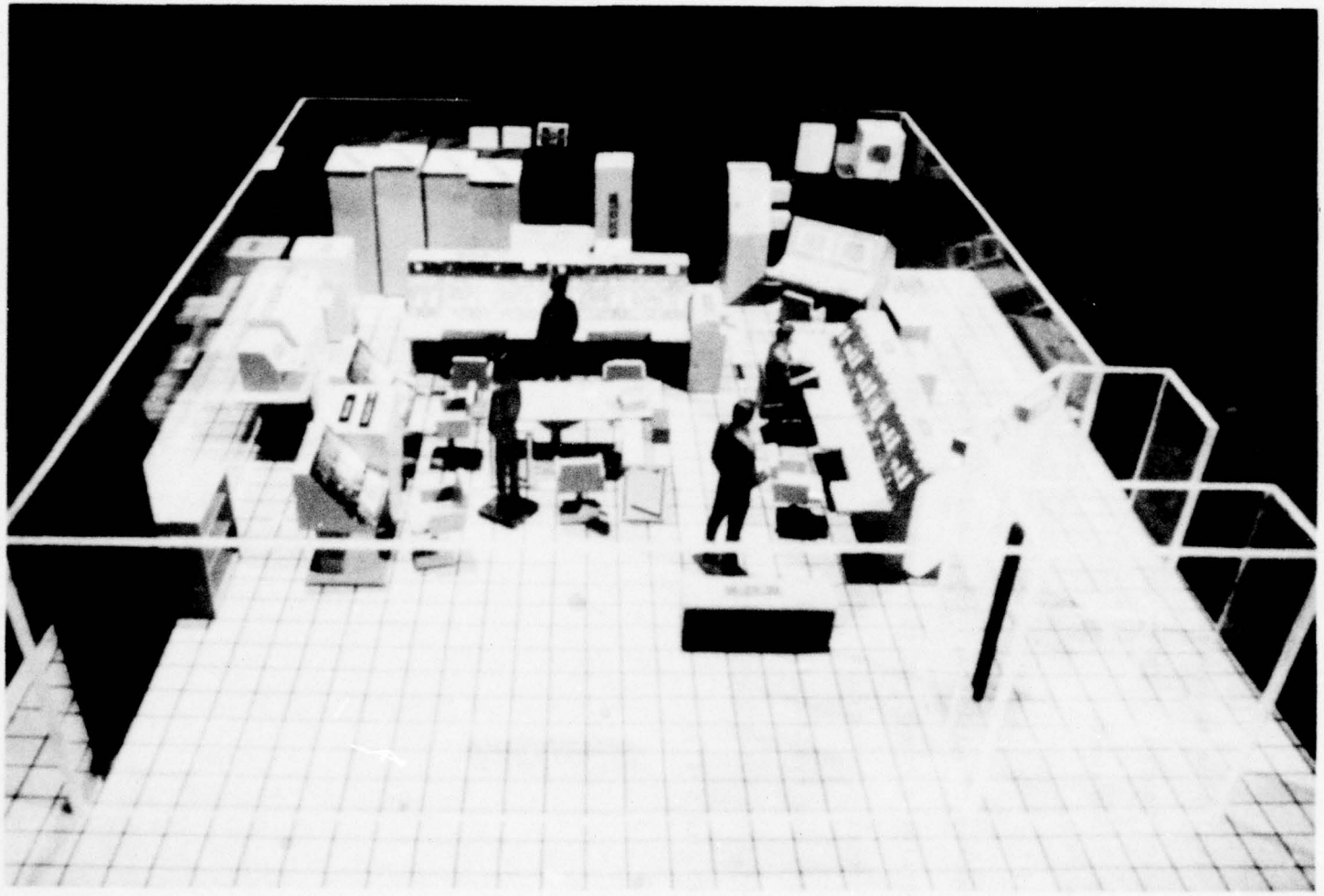


Figure C-18. NMCC emergency action room - recommended equipment layout.

NATIONAL MILITARY COMMAND CENTER - PENTAGON

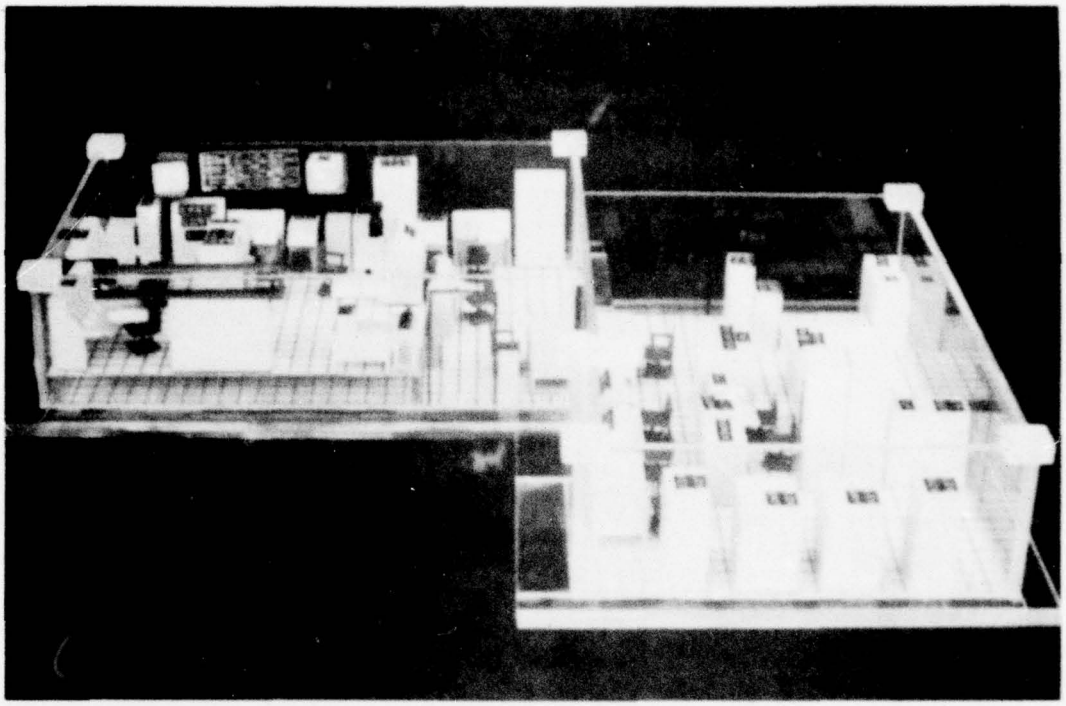
EMERGENCY ACTION ROOM (EAR)

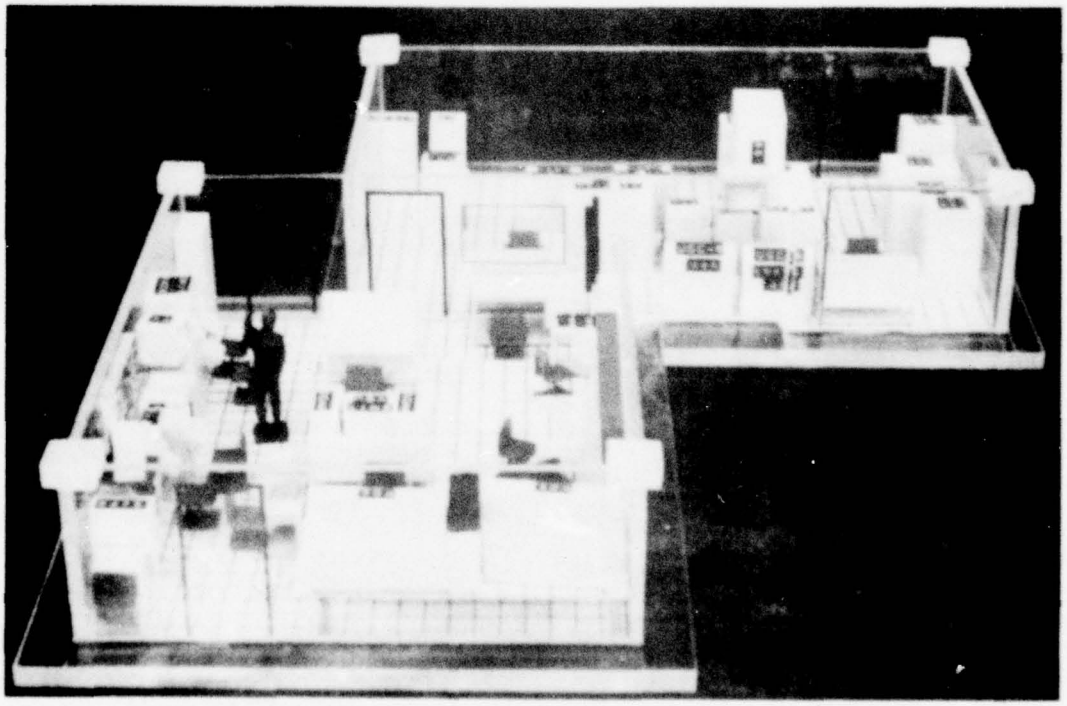
Objective:

To develop a plan that will permit orderly introduction of new equipments into the NMCC Emergency Action Room without disrupting day-to-day operations.

Results:

Two- and three-dimensional models of present and proposed equipments and the EAR were constructed. The existing layout of equipment in the room was configured on the mockup and a recommended sequence of removal and installation of equipments was developed to accommodate proposed new equipment. This sequence was then videotaped on the mockup to effectively communicate the recommended sequence to DCA sponsors. See Figure C-18.





Figures C-19A and C-19B. Model of the ANMCC emergency action spaces.

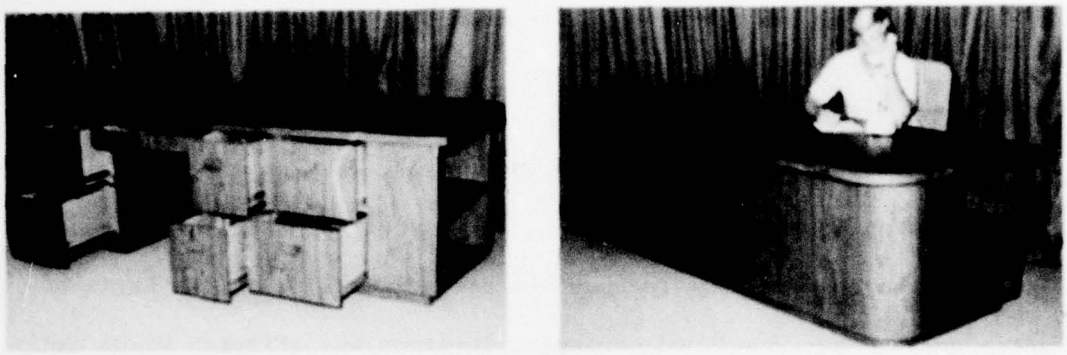
ALTERNATE NATIONAL MILITARY COMMAND CENTER

Objective:

To provide recommendations for improving operations associated with generating and transmitting EAMs as influenced by room and equipment arrangements and the operating environment.

Results:

Collected and analyzed data on operations, environment, room layout and equipment arrangements at the site. A model of the ANMCC was constructed and analyzed to develop a recommended reconfiguration on the basis of personnel and personnel and equipment interactions (Figures C-19A and C-19B).



Figures C-20A and C-20B. Prototype mockup of proposed CAC watch officer's work station.

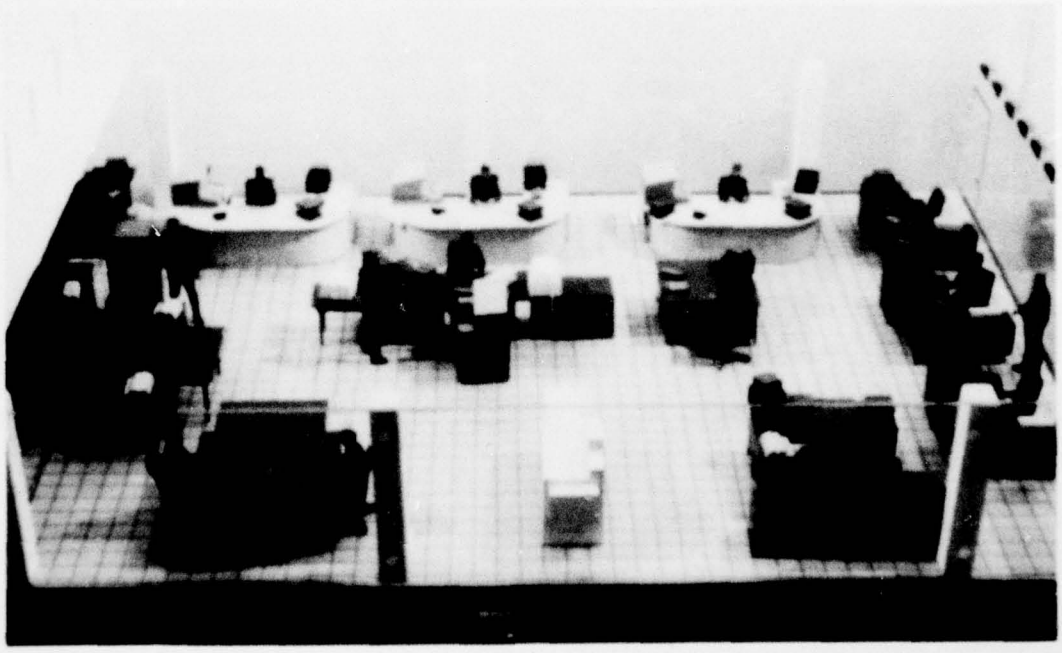


Figure C-21. Model of NMCC Current Action Center.

NATIONAL MILITARY COMMAND CENTER - PENTAGON

CURRENT ACTION CENTER

Objective:

To provide a redesigned work station and equipment layout in the CAC to optimize operations.

Results

On the basis of observations and data on CAC operations, models of three possible work station configurations were designed, construced and sent to the using agency for their comments and evaluation. Following these evaluations a full-scale version of the prefferred work station configuration was designed and constructed to accommodate new equipments and to consolidate other components. See Figures C-20A and C-20B.
A reduced-scale mockup of the CAC and installed equipment was constructed and used as a design tool to develop rearrangement recommendations for equipment in the CAC (Figure C-21).

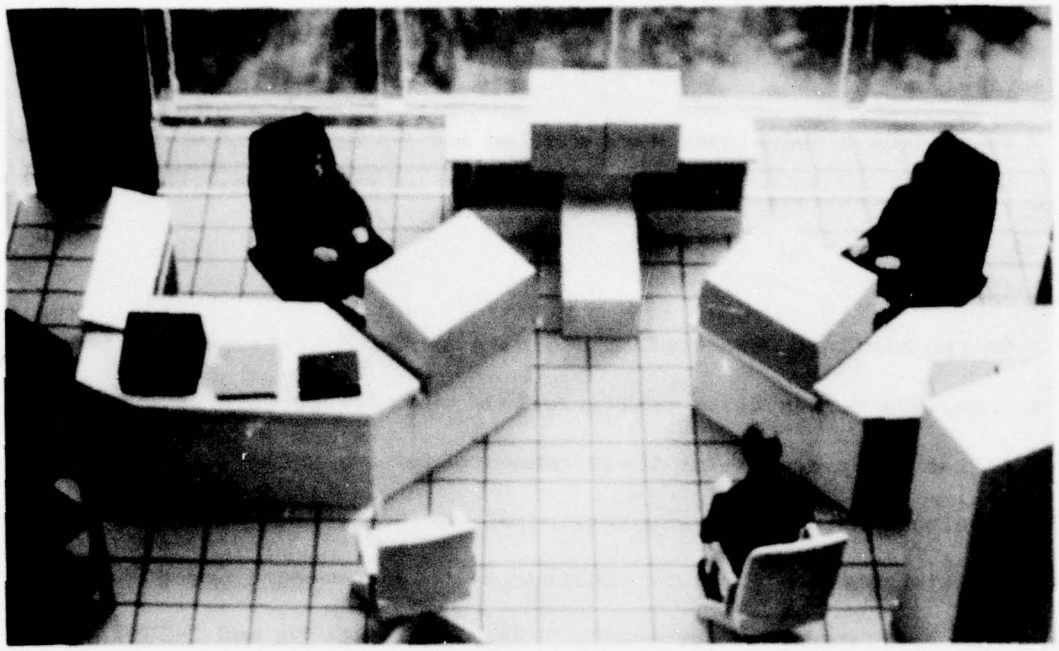


Figure C-22. Recommended layout of proposed DDO and ADDO work stations in the NMCC.

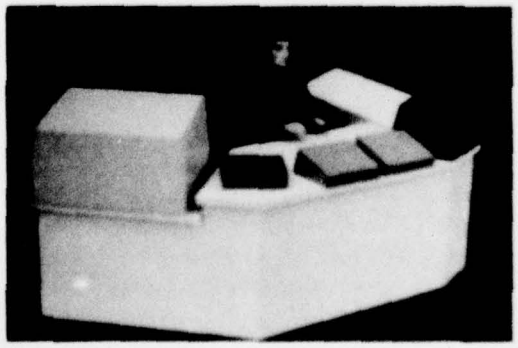


Figure C-23A. Model of Recommended DDO work station.

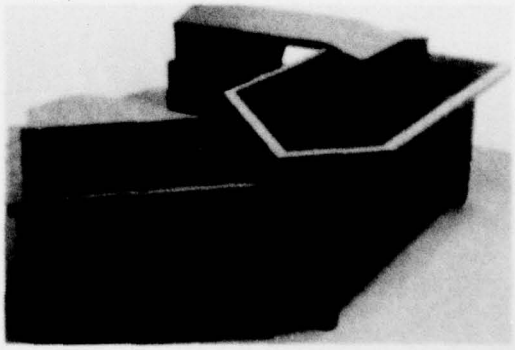


Figure C-23B. Prototype mockup of recommended DDO work station.

NATIONAL MILITARY COMMAND CENTER - PENTAGON

DUTY OFFICER (DDO) AND ASSISTANT DDO WORK STATIONS

Objective:

To develop a configuration and equipment arrangement of the work stations including new equipments for ease of operations.

Results:

Several alternative configurations of the work stations were developed and constructed in reduced-scale form following interviews with various DDOs and ADDOs and an analysis of their requirements. The preferred work station was constructed full-scale and shipped to the Pentagon for user evaluation. See Figures C-22, C-23A and C-23B.

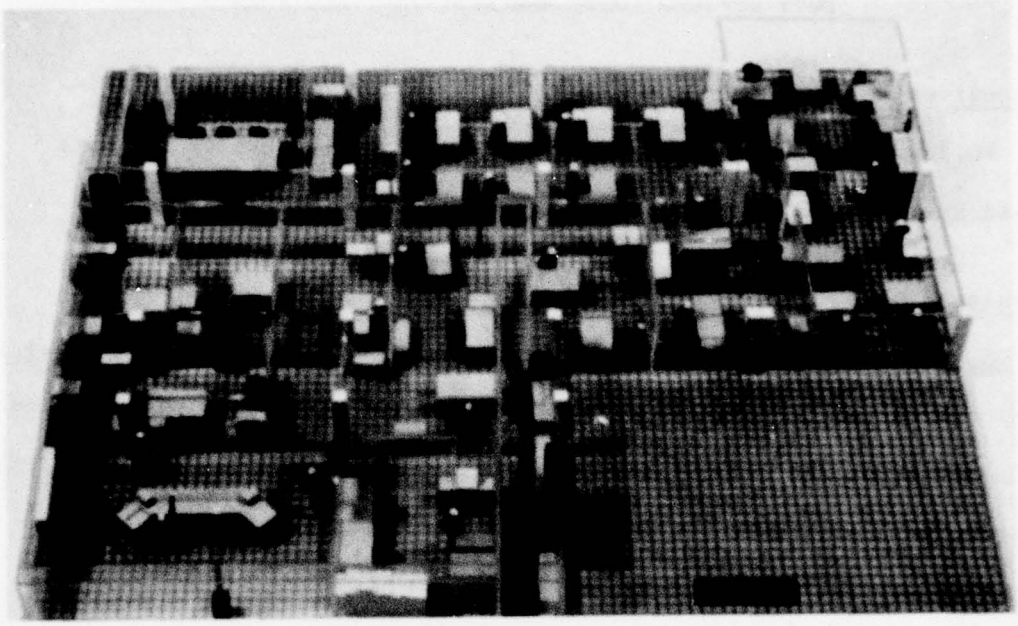


Figure C-24. NMCC joint reconnaissance center showing relocated JRC operations room.

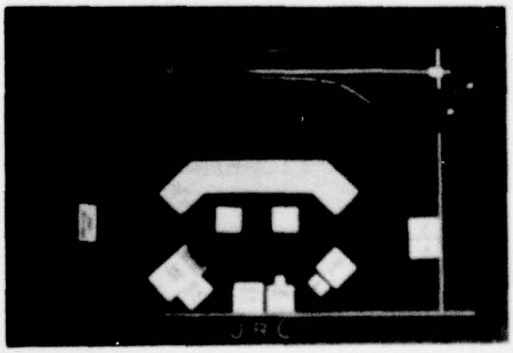


Figure C-25A. Two-dimensional model of recommended JRC operations room layout.

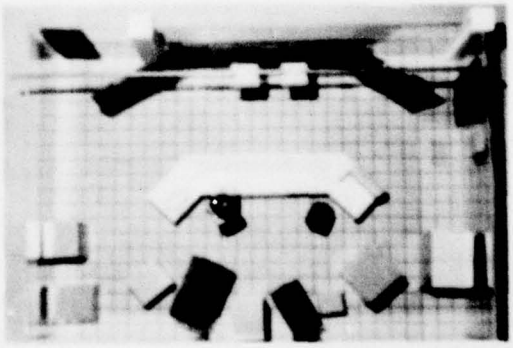


Figure C-25B. Three-dimensional model of recommended JRC operations room layout.

NATIONAL MILITARY COMMAND CENTER - PENTAGON

JOINT RECONNAISSANCE CENTER OPERATIONS ROOM

Objective:

To develop a recommended rearrangement of the JRC Operations Room equipment to provide better physical and visual access to equipments and controls and displays.

Results:

Two- and three-dimensional models of the present Operations Room and equipments were constructed to identify man-machine interaction problem areas together with operating personnel. Rearrangement alternatives were then developed and a preferred configuration was recommended. See Figures C-24, C-25A and C-25B.

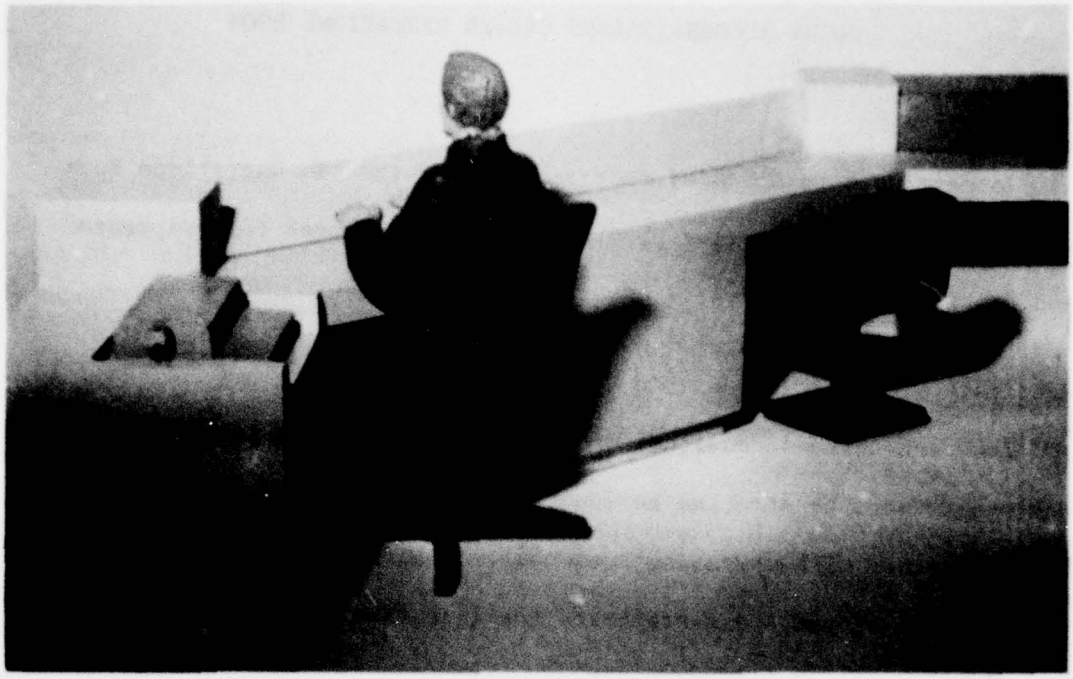


Figure C-26A. Model of recommended JRC watch officer's console.

Figure C-26B. Mockup of recommended JRC watch officer's console.

JOINT RECONNAISSANCE CENTER (JRC)

WATCH OFFICER'S CONSOLE

Objective:

To design a JRC watch officer's console configuration and control panel to improve communications capability at this work station.

Results:

Man-equipment interaction problems and possible solutions were determined jointly by NOSC and operational personnel. Reduced-scale mockups of alternative configurations for the console were then developed and evaluated by watch officers and the preferred configuration was selected. A full-scale mockup of this configuration was constructed for further evaluation as well as to develop a design for the console control panel. See Figures C-26A and C-26B.

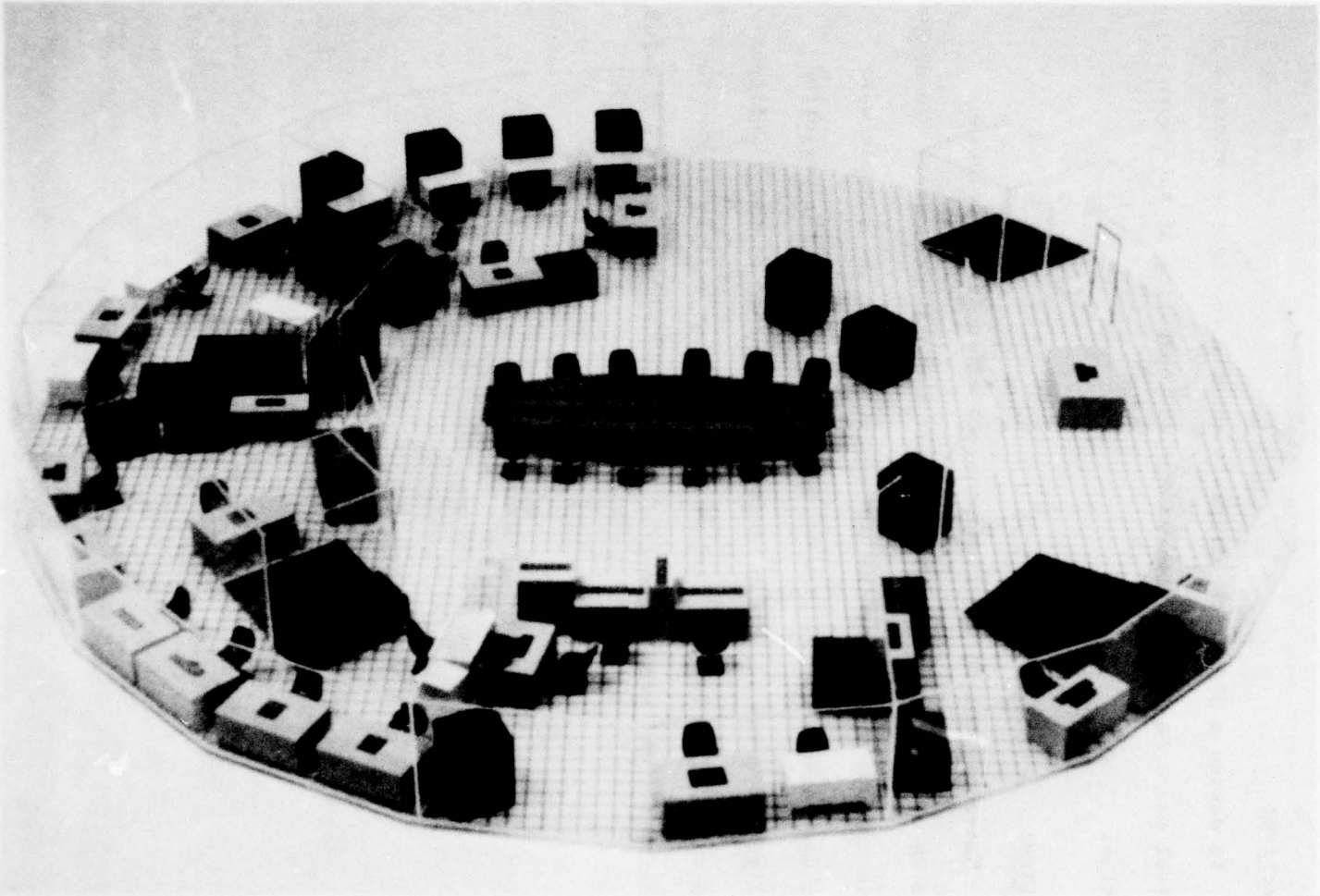


Figure C-27. Model of survivable command center layout concept.

SURVIVABLE COMMAND CENTER

Objective:

To develop an arrangement of equipment and facilities to optimize interactions between personnel and personnel and equipment during Center operations.

Results:

Potential man-machine interaction problem areas for a proposed Center configuration were identified using a 1/24 scale model of the Center (Figure C-27).

Figure C-28. Model of proposed layout of radio compartment of EC-135 airborne command post.

EC-135 AIRBORNE COMMAND POSTS

Objective:

To evaluate and develop alternative arrangements of equipment in the radio compartments of the EC-135 Airborne Command Posts.

Results:

Models of four EC-135 aircraft configurations were constructed to develop and study alternate locations of existing and proposed new equipments in the radio compartments. Sponsors and user representatives from the CINCs and OCALA participated in a technical interchange meeting at NOSC to accomplish the above using the mockups as study vehicles. The working sessions were videotaped for the benefit of other interested personnel who did not attend the meeting. See Figure C-28. A model of the CINCPAC EC-135 aircraft configuration was shipped to CINCPAC for user studies and training.

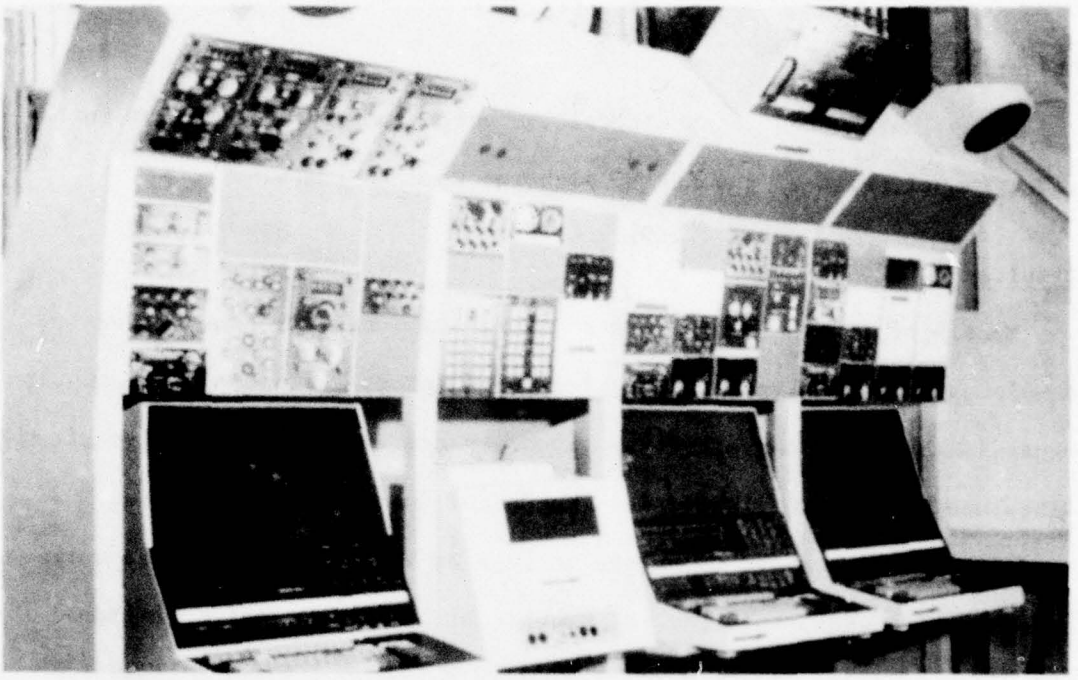


Figure C-29A. Mockup of preliminary panel layout for the IRDS console.

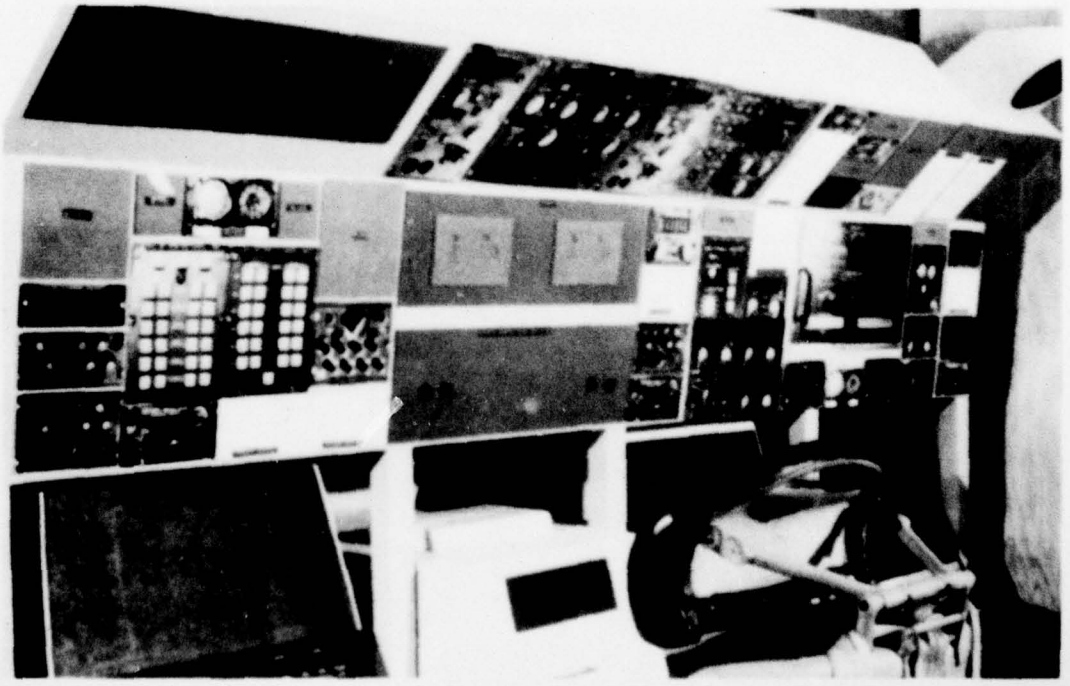


Figure C-29B. Mockup of recommended panel layout for the IRDS console.

INTEGRATED RECORD DATA SYSTEM (IRDS) FOR WWMCS EC-135 AIRCRAFT

Objective:

To determine optimum work station and equipment front panel component locations for the IRDS operators' control console.

Results:

A mockup of the IRDS was constructed to simulate a proposed console and installed equipment such as communications equipment control panels, keyboard/display units, printers, etc. An alternative console design proposal was developed through an analysis of operators' needs, duties and frequency of use of various components and accessibility requirements to communications equipment controls and displays. Photographs of front panels were attached to relocatable magnetically-attached plates to quickly develop and evaluate alternative front panel configurations. The selected configuration was then photographed to document the proposed reconfiguration. See Figures C-29A and C-29B.

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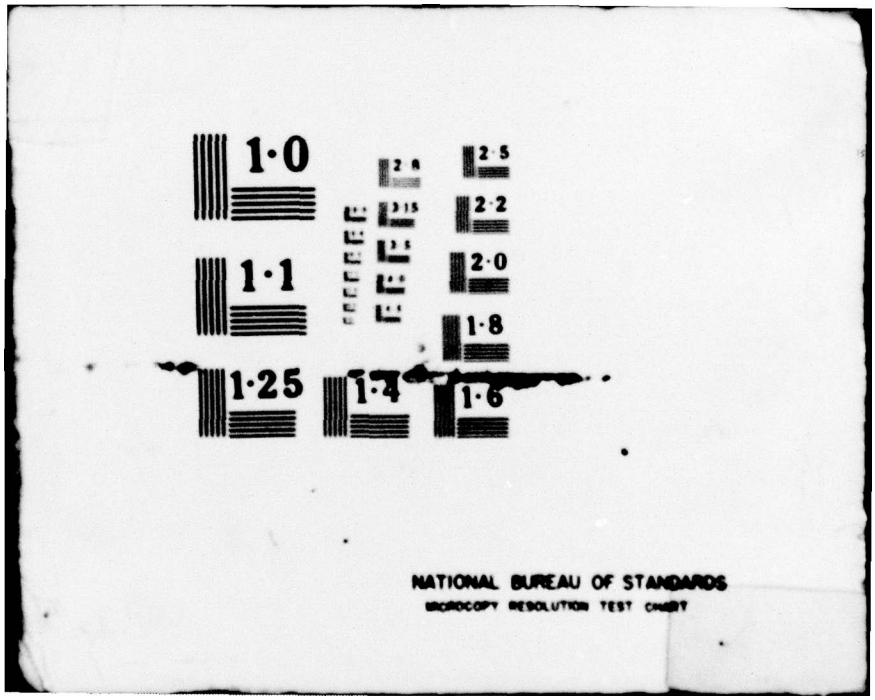
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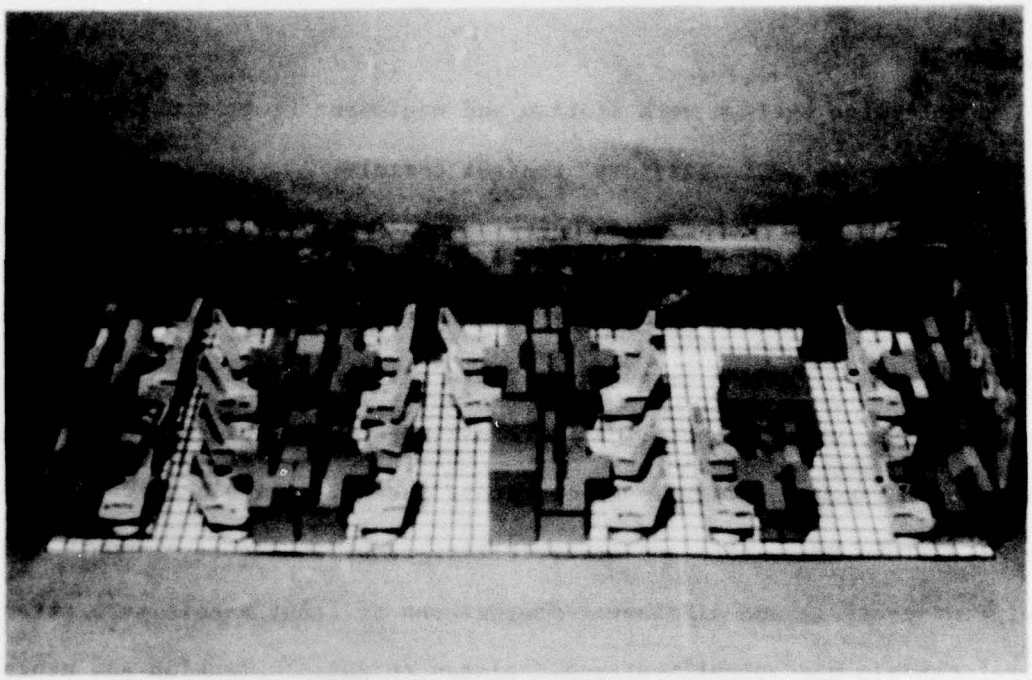

Figure C-30A. Model of E-4A NEACP battle staff area.

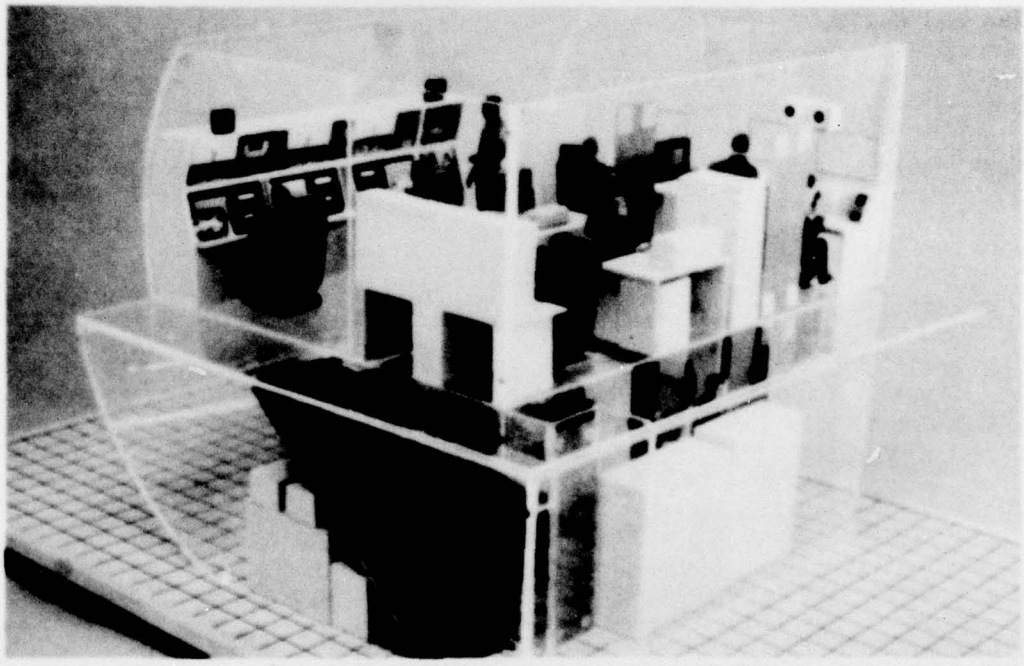

Figure C-30B. Model of E-4A NEACP radio control compartments.

E-4A NATIONAL EMERGENCY AIRBORNE COMMAND POST (NEACP)

Objective:

To identify problems in the generation of EAMs and make recommandations for improving operations through equipment proposals and locations.

Results:

An NOSC study team obtained data during an airborne operations exercise. These data were analyzed in conjunction with models of the radio and battle staff compartments to study the personnel actions and movements in generating EAMs and to investigate alternative locations of proposed terminals to expeditiously generate and verify these EAMs. See Figures C-30A and C-30B.

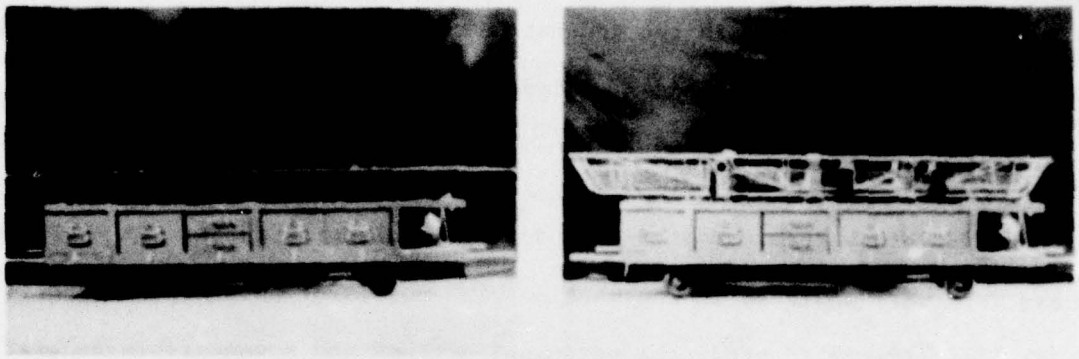

Figure C-31A. Mockup of portable life support stretcher.

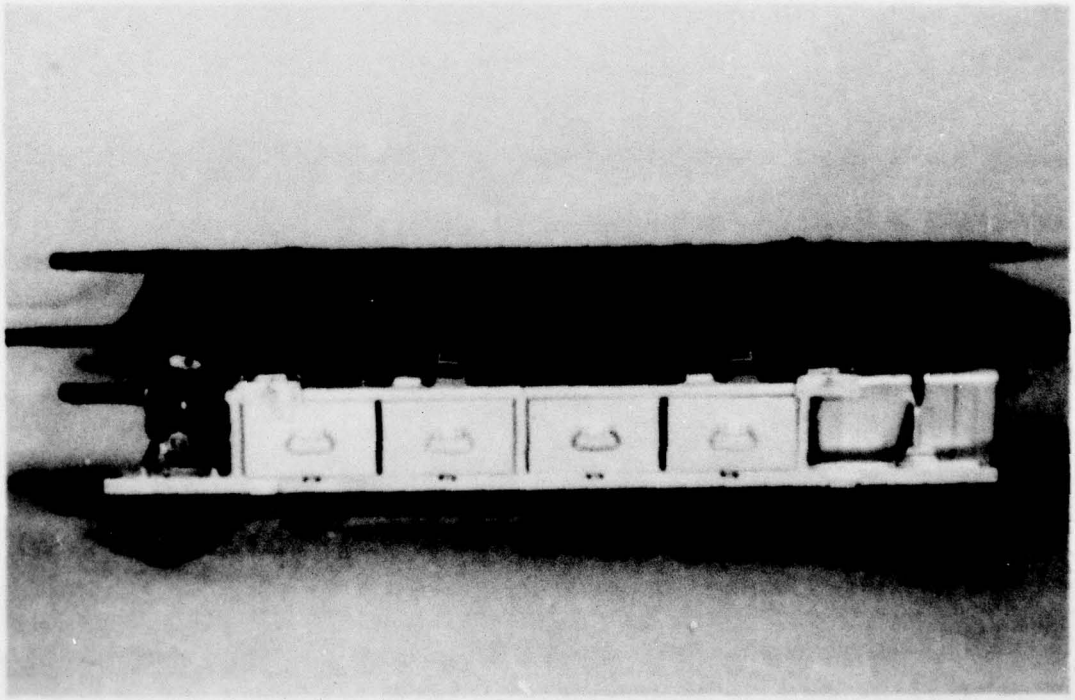

Figure C-31B. Engineering prototype of portable life support stretcher.

PORTABLE LIFE SUPPORT STRETCHER

Objective:

To design a portable life support stretcher that would satisfy the need for providing continuous, uninterrupted casualty care and monitoring during the transportation phase of Medevac operations. The unit had to be compatible with military ground vehicles, surface ships and rotary or fixed-wing aircraft used for patient transport.

Results:

A mockup of a stretcher design was constructed and alternative locations and arrangements of medical equipment and supplies contained within the stretcher were studied to develop a functional arrangement for these items. Preliminary evaluations were made in terms of compatibility with military ground vehicles and aircraft. These evaluations led to the construction of an engineering prototype for more detailed evaluations. See Figures C-31A and C-31B.

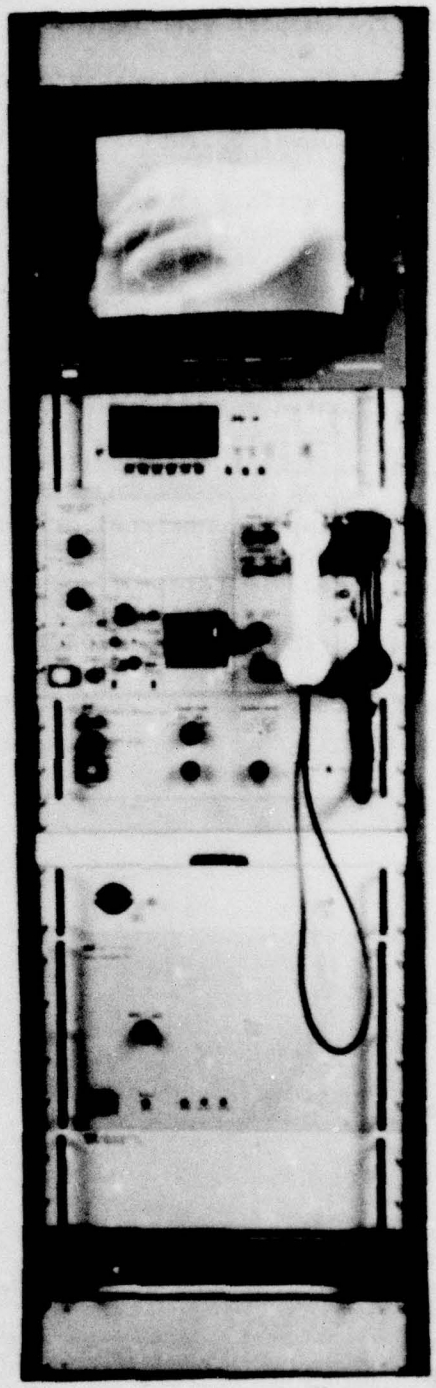

Figure C-32. Prototype mockup of remote medical diagnosis system.

REMOTE MEDICAL DIAGNOSIS SYSTEM (RMDS)

Objective:

To develop specifications for a slow scan video system for the Navy for ship-to-shore transmission of emergency medical consultations.

Results:

A mockup of an RMDS equipment arrangement concept was constructed to determine how best to arrange the system and locate various components. The initial concept was modified to accommodate various requirements and restraints leading to the development of specifications for the system (Figure C-32).

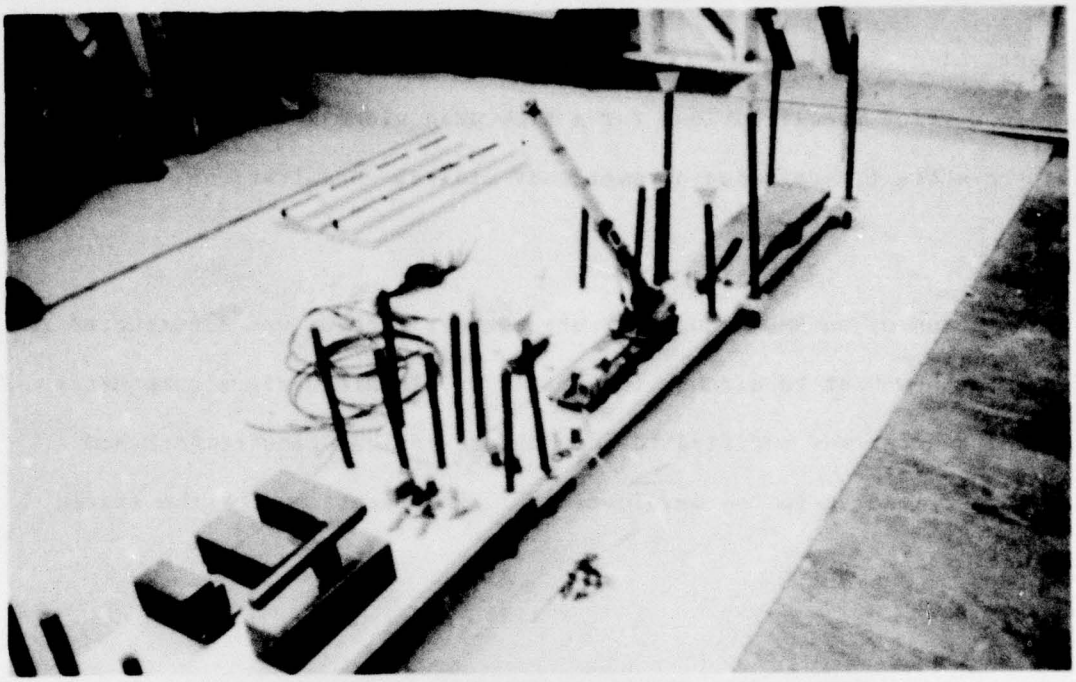

Figure C-33A. 1:48 scale model of COTS system.

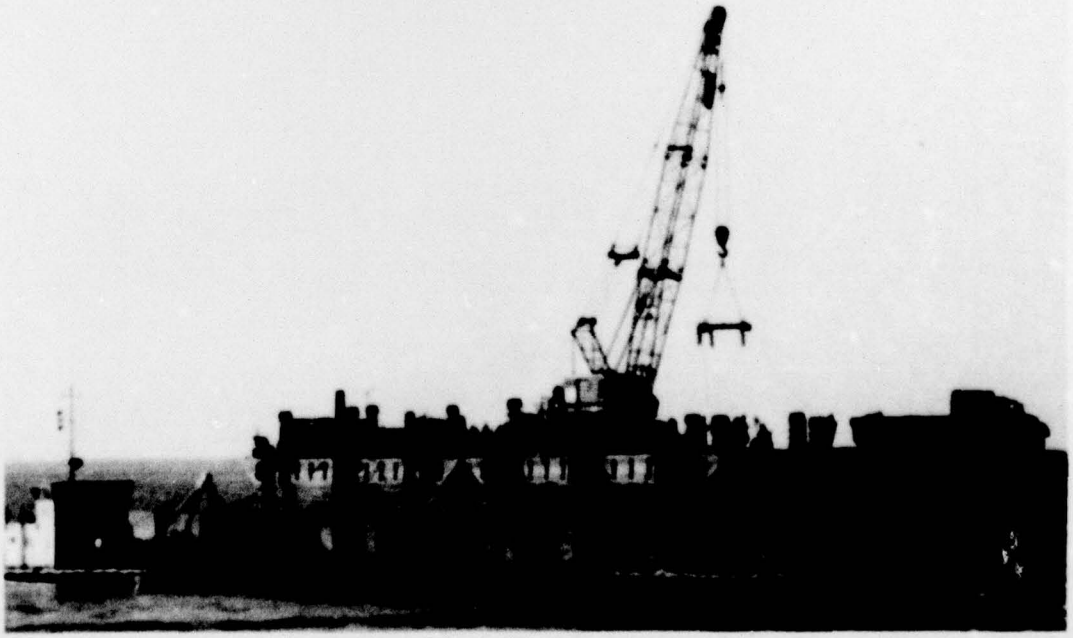

Figure C-33B. Actual COTS system.

CEL – CONTAINER OFF-LOADING AND TRANSFER SYSTEM (COTS)

Objective:

To develop sequences of pier construction activities to reduce the time for pier construction and to more efficiently utilize personnel and equipment.

Results:

Models of pier causeway sections, components and equipment including operating personnel were constructed to provide a tool for simulating pier construction sequences. An optimum sequence was then developed, implemented and verified during actual pier construction. A 40% reduction in pier construction time and a 30% reduction in personnel requirements was realized using the recommended job assignments, construction sequences and procedures developed through studies performed on the model. The mockup was also used for training Navy Construction Battalion (CB) pier construction personnel, primarily in terms of what and when tasks had to be performed and who was to perform them. Individual task time data were collected on site using video recording techniques (Figures C-33A and C-33B).

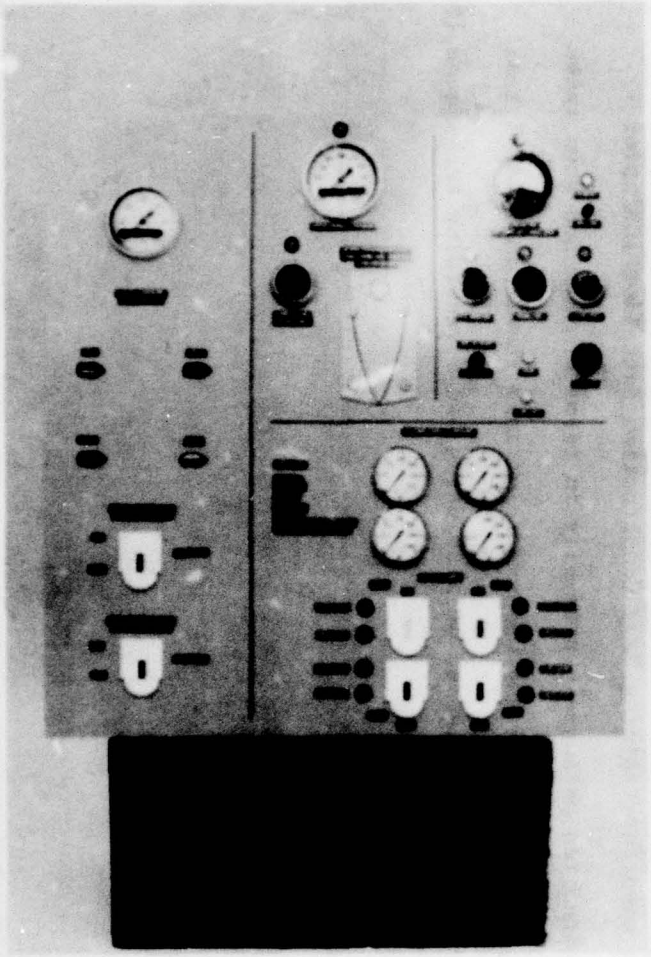

Figure C-34A. Mockup of recommended reconfiguration of COTS hydraulic jack control unit control panel.

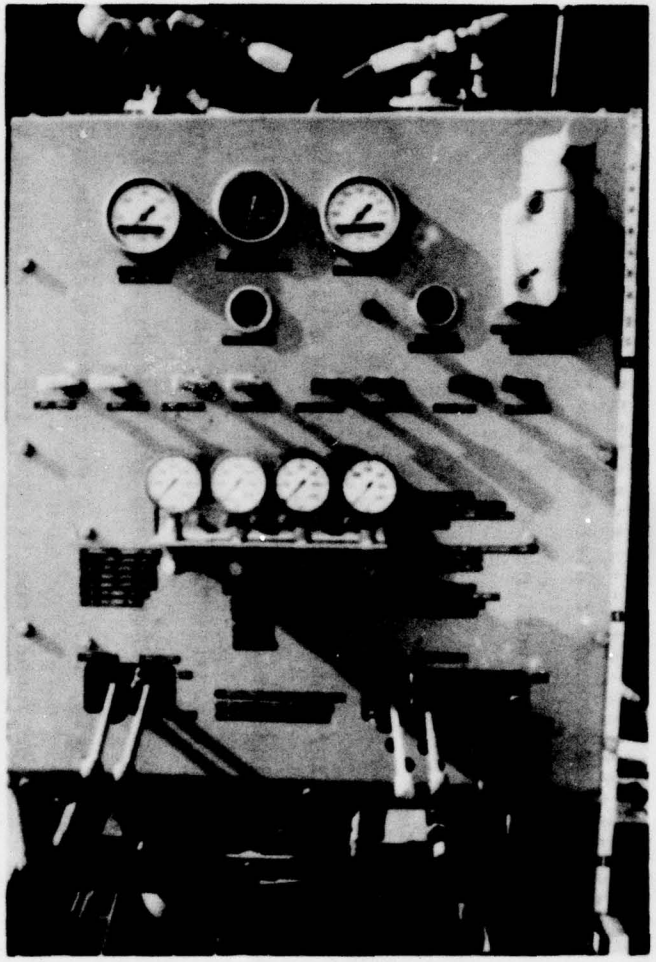

Figure C-34B. Actual COTS hydraulic jack control unit.

CONTAINER OFF-LOADING AND TRANSFER SYSTEM (COTS) - HYDRAULIC JACK - CIVIL ENGINEERING LABORATORY (CEL)

Objective:

To develop recommendations for improvement in the design of the COTS hydraulic jack power control unit for more effective set-up and operation.

Results:

A mockup of the power control unit front panel was constructed including simulated controls and indicators which were attached to a sheet metal panel with magnetic tape. Alternative arrangements of these components were developed and evaluated to determine a preferred arrangement. In particular, it was recommended that diesel engine indicators and controls located on the side of the console be relocated to the front panel for rapid viewing and operation, respectively. Also recommended were functional groupings of related controls and indicators, shape coding of jack lift and hold valve control levers, and recessing of hydraulic connections to minimize damage potential. See Figures C-34A and C-34B.

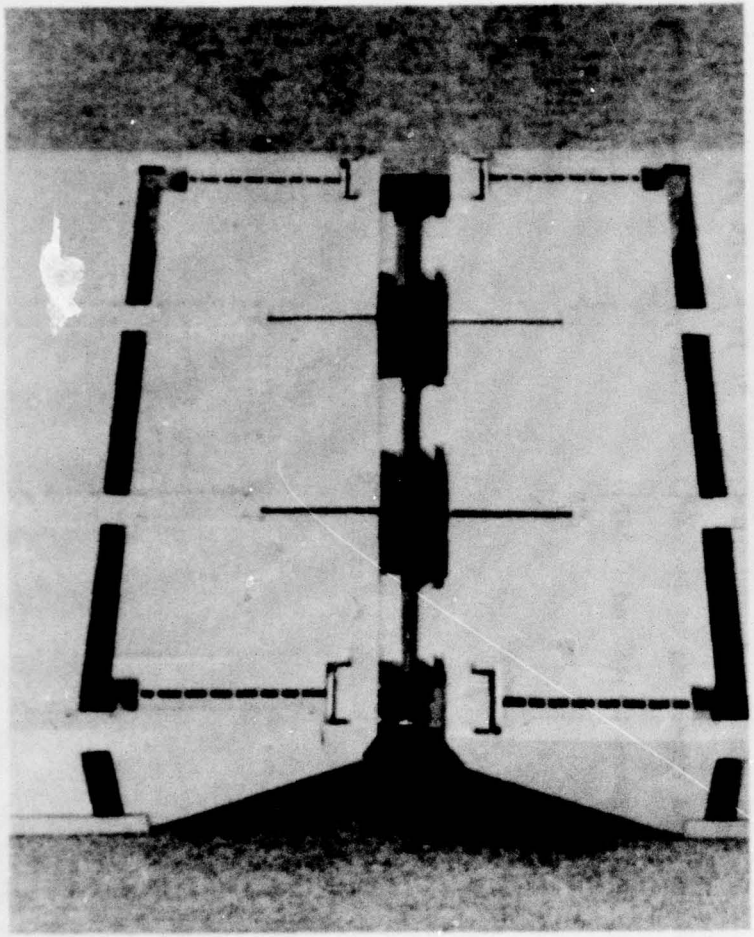

Figure C-35A. CEL causeway section model (flexor connection).

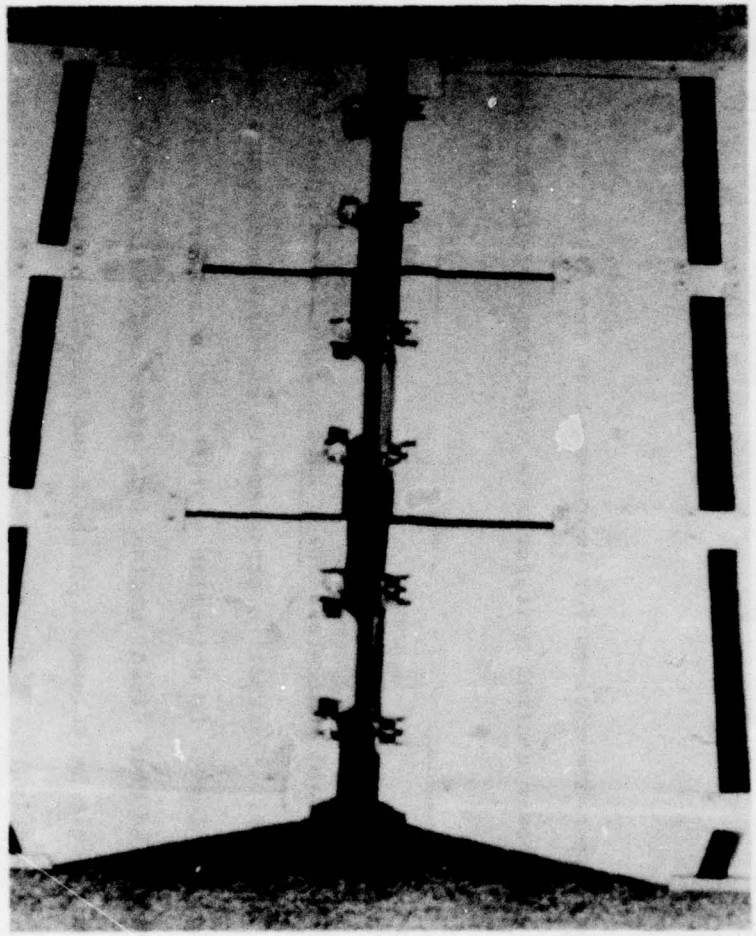

Figure C-35B. CEL causeway section model (link connection).

CEL CONTAINER AND OFF-LOADING AND TRANSPORT SYSTEM (COTS)

CAUSEWAY SECTIONS

Objective:

To provide a means of effectively presenting concepts and features of causeway section designs.

Results:

Three-dimensional models of proposed causeway section designs were constructed. A high degree of realism was provided in the model to illustrate functional aspects of side- and end-connector design features. The models were shipped to the sponsor for evaluations and presentations. See Figures C-35A and C-35B.